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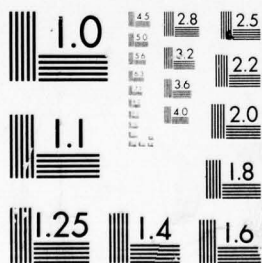
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84-IN. PROPELLANT CARTRIDGES AND GRAINS

Volume II — Propellant Test Data

Terry V. O'Hara
Joseph B. Henry
Wendell A. Stephen

United Technologies Corporation
Chemical Systems Division
P. O. Box 358
Sunnyvale, CA 94088

30 November 1977

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AFPRO
Chemical Systems Division
P. O. Box 358
Sunnyvale, CA 94088

Prepared for

AIR FORCE ROCKET PROPULSION LABORATORY
Director of Science and Technology
Air Force Systems Command
Edwards Air Force Base, CA 93523

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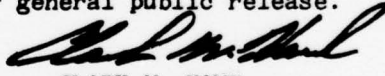
FOREWARD

This report was submitted by United Technologies/Chemical Systems Division, P.O. Box 358, Sunnyvale, CA 94086, under Contract No. FO4611-76-C-0010, Job Order No. 305909 JM with the Air Force Rocket Propulsion Laboratory, Edwards AFB, CA 93523.

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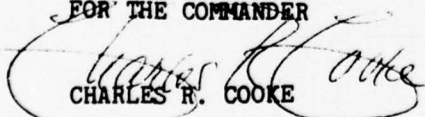

THOMAS L. KINSEL

Project Manager


CLARK W. HAWK

Acting Branch Chief

FOR THE COMMANDER


CHARLES R. COOKE

Director, Solid Rocket Division

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18. SUPPLEMENTARY NOTES This report is presented in three volumes: Volume I - Technical Discussion Volume II - Propellant Test Data Volume III - Appendices		
19. KEY WORDS (Continue on reverse side if necessary and identify by block number) HTPB Propellant High Solids Loaded Propellant UTP-18,803A ELSH Loaded Cartridges CHAR Loaded Cartridges Propellant Characterization 84-Inch Cartridge		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) This document reports the results obtained from casting a total of 30 84-inch cartridges with UTP-18,803A propellant (90% solids, 21% aluminum, HTPB). Both ballistic and mechanical property data obtained during the production of over 730,000 lbs of propellant is presented. Documentation for propellant production is provided. K		

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CONTENTS

<u>Section</u>		<u>Page</u>
1.0	INTRODUCTION	3
2.0	CSD BALLISTIC AND MECHANICAL PROPERTY TEST DATA AND DATA CORRELATIONS	4
2.1	Five-Gallon Preproduction Batches	5
2.2	400-Gallon Preproduction Batch (Batch 400-1450)	15
2.3	Production Run No. 1 (Batches 400-1454 through 400-1465)	21
2.4	Production Run No. 2 (Batches 400-1468 through 400-1479)	33
2.5	Production Run No. 3 (Batches 400-1480 through 400-1491)	47
2.6	Production Run No. 2A (Batches 400-1495 through 400-1503)	59
2.7	Production Run No. 3A (Batches 400-1505 through 400-1515)	69
2.8	Production Run No. 4 (Batches 400-1516 through 400-1526)	81
2.9	Production Run No. 5 (Batches 400-1527 through 400-1537)	99
2.10	Production Run No. 6 (Batches 400-1539 through 400-1543)	109
2.11	Production Run No. 7 (Batches 400-1546 through 400-1557)	117
2.12	Production Run No. 8 (Batches 400-1574 through 400-1582)	135
2.13	Production Run No. 9 (Batches 400-1588 through 400-1600)	145
2.14	Production Run No. 10 (Batches 400-1606 through 400-1615)	157
2.15	Production Run No. 11 (Batches 400-1620 through 400-1629)	167
3.0	AP PARTICLE SIZE DISTRIBUTIONS	76
4.0	FIFTEEN-POUND BATES TEST DATA	200
5.0	SEVENTY-POUND BATES TEST DATA	264

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BDC	Buff Section <input type="checkbox"/>
UNANNOUNCED	<input type="checkbox"/>
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1.0 INTRODUCTION

Volume II of the final report presents a compilation of all the ballistic and mechanical property test data for UTP-18,803A obtained under contract No. F04611-76-C-0010. The data presented here are those which were used in the statistical data summaries presented in section 4.2.1 of Volume I.

Because of the large amount of data available, the presentation of the data in this volume has been categorized into four main topics for ease of reference.

<u>Volume II</u> <u>Section No.</u>	<u>Data Description</u>
2.0	<u>CSD Ballistic and Mechanical Property Test Data and Data Correlation</u> - This section presents the test data obtained by CSD for each batch of propellant. Both ballistic (LSBR, CSBR, 4-lb motor) and physical property data are presented. Correlations between CSD and AFRPL test data are given. All test data are given by batch number and grouped by production run number.
3.0	<u>AP Particle Size Distribution</u> - The AP particle size distributions in terms of cumulative percentages are given for both the ground and unground AP. These data were used to establish the AP grind ratio for those batches where D_{43} was used as the propellant burning rate control. Data are presented by batch number.
4.0	<u>Fifteen-Pound BATES Test Data</u> - This section presents a plot of the pressure and thrust duty cycles for each of the 15-lb BATES motors test fired by AFRPL. The primary ballistic parameters for each test are also tabulated. The data are presented by batch number.
5.0	<u>Seventy-Pound BATES Test Data</u> - This section presents a plot of the pressure and thrust duty cycles for each of the 70-lb BATES motors test fired by AFRPL. The primary ballistic parameters for each test are also tabulated. The data are presented by batch number.

2.0 CSD BALLISTIC AND MECHANICAL PROPERTY TEST DATA AND DATA CORRELATIONS

This section presents the test data obtained by CSD for each batch of UTP-18,803A produced under contract No. F04611-76-C-0010. Both the ballistic (LSBR, CSBR, 4-lb motor) and mechanical property test data are presented. The ballistic correlations between the CSD and AFRPL test data are also given. All test data are presented by production run and batch number.

Five Gallon
Preproduction
Batches

Batch	Volume	Weight	Concentration	Temperature	Pressure	Time	Notes
1.1	10000	100	100	100	100	100	
1.2	10000	100	100	100	100	100	
1.3	10000	100	100	100	100	100	
1.4	10000	100	100	100	100	100	
1.5	10000	100	100	100	100	100	
1.6	10000	100	100	100	100	100	
1.7	10000	100	100	100	100	100	
1.8	10000	100	100	100	100	100	
1.9	10000	100	100	100	100	100	
1.10	10000	100	100	100	100	100	

SECTION 2.1

FIVE-GALLON PREPRODUCTION BATCHES

Five Gallon
Preproduction

4-LB MOTOR

18803A DATA

<u>Batch</u>	<u>Grind Ratio</u>	<u>NCO/OH</u>	<u>r₁₀₀₀ in/sec</u>	<u>r₁₄₀₀ in/sec</u>	<u>Exponent η</u>	<u>Burning Rate Constant a</u>	<u>One Sigma %</u>
5-1711	65/35	.86	.415	.487	.472	.01591	1.8
5-1712	60/40	.86	.439	.538	.603	.00682	1.8
5-1713	55/45	.86	.489	.594	.583	.00867	2 pt
5-1714	65/35	.83	.411	.490	.522	.01116	2.2
5-1715	60/40	.83	.442	.530	.543	.01038	1.2
5-1716	55/45	.83	.482	.577	.534	.01209	2 pt
5-1717	65/35	.80	.413	.496	.547	.00943	3.2
5-1718	60/40	.80	.457	.554	.573	.00872	3.6
5-1719	55/45	.80	.473	.581	.610	.00700	2 pt

Five Gallon
Preproduction

Project 2579
UTP 18803A

4# Motor Burn Rate Data

	<u>S/N</u>	<u>psi</u>	<u>in/sec</u>
Batch 5-1711	13	1428	.495
	09	757	.369
	19	951	.397
Batch 5-1712	11	1920	.655
	17	831	.398
	12	1103	.456
Batch 5-1714	22	1472	.508
	01	956	.392
	20	751	.360
Batch 5-1713	15	Overpressurization, nozzle ejected	
	27	1483	.614
	23	969	.479
Batch 5-1715	5	827	.402
	24	1061	.450
	25	1843	.618
Batch 5-1716	21	934	.465
	10	1395	.576
	3	Motor blew	
Batch 5-1717	08	721	.354
	02	906	.377
	06	1493	.520
Batch 5-1718	18	825	.421
	26	1072	.456
	16	2034	.694
Batch 5-1719	07	962	.462
	04	1342	.566
	14	Motor blew	

2C MICRO (2 X 4) MOTOR

UTP 18803A

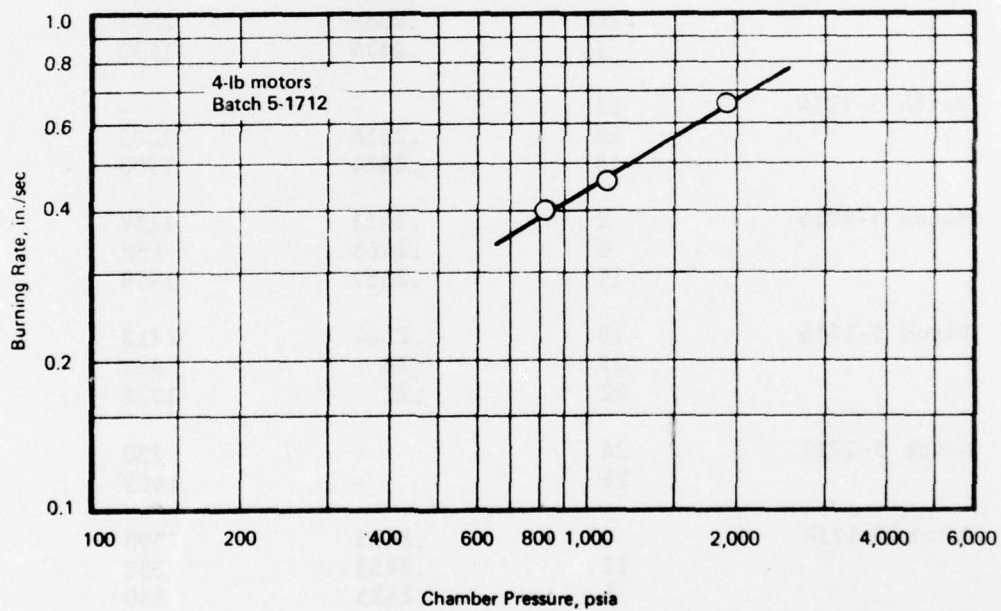
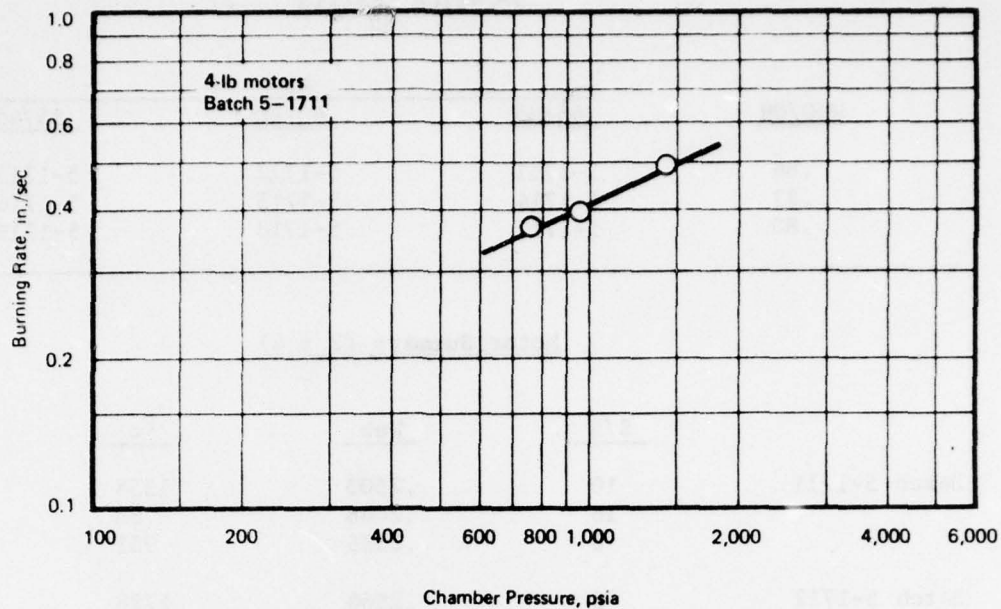
<u>Batch</u>	<u>Grind Ratio</u>	<u>NCO/OH</u>	<u>r₁₀₀₀ in/sec</u>	<u>r₁₄₀₀ in/sec</u>	<u>Exponent η</u>	<u>Burning Rate Constant a</u>	<u>One Sigma %</u>
5-1711	65/35	.86	.445	.508	.397	.0287	2.4
5-1712	60/40	.86	.482	.593	.615	.00688	2.1
5-1713	55/45	.86	.522	.686	.814	.00189	3.1
5-1714	65/35	.83	.484	.586	.573	.00926	2 pt
5-1715	60/40	.83	.467	.580	.641	.00560	4.61
5-1716	55/45	.83	.499	.723	1.11	.00024	9.4
5-1717	65/35	.80	.442	.5096	.423	.02385	2 pt
5-1718	60/40	.80	.477	.573	.543	.01123	0.3
5-1719	55/45	.80	.531	.772	1.106	.00026	2 pt

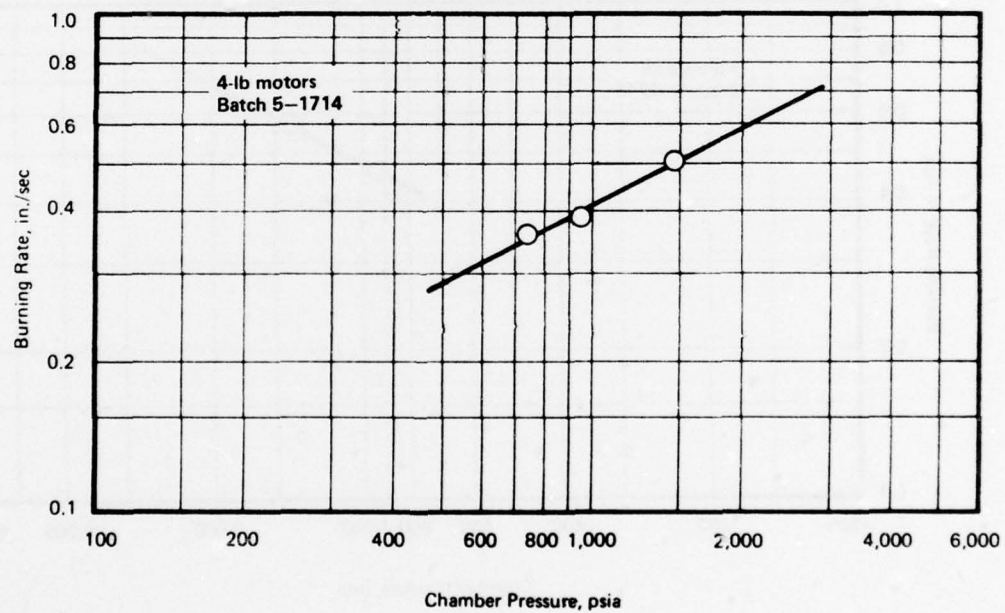
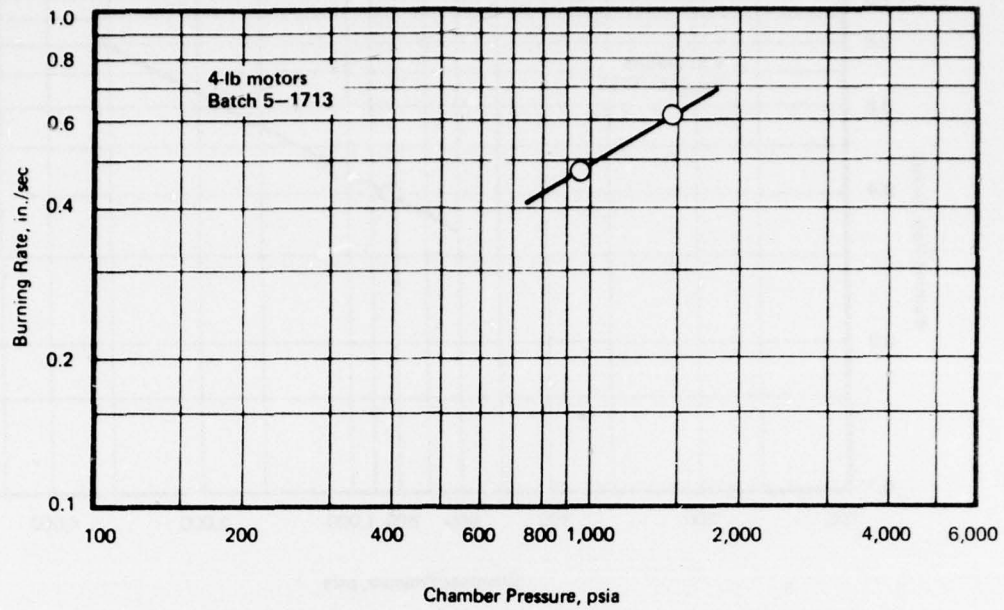
Project 2579
UTP 18803A
5-Gallon Matrix

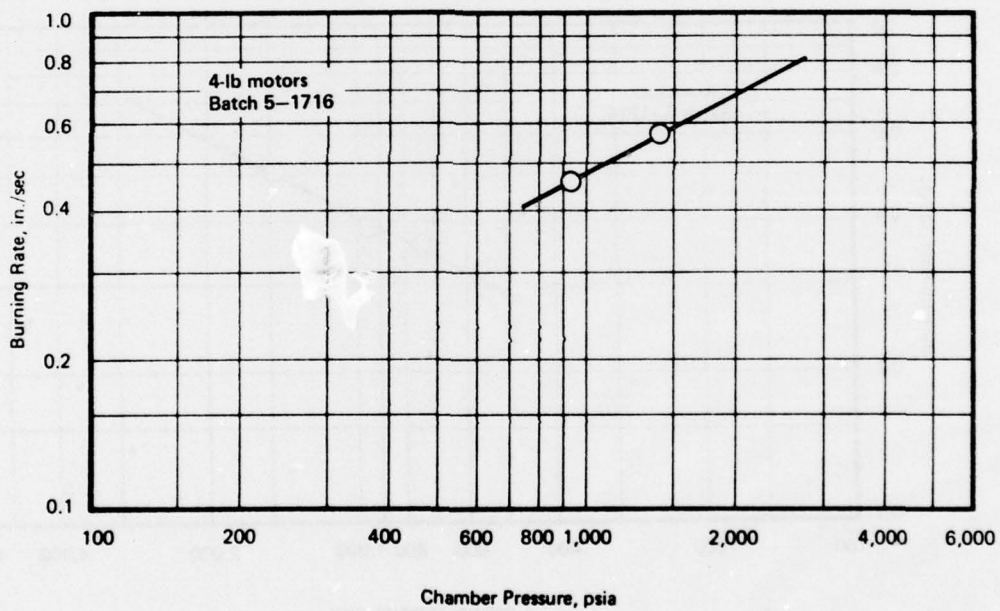
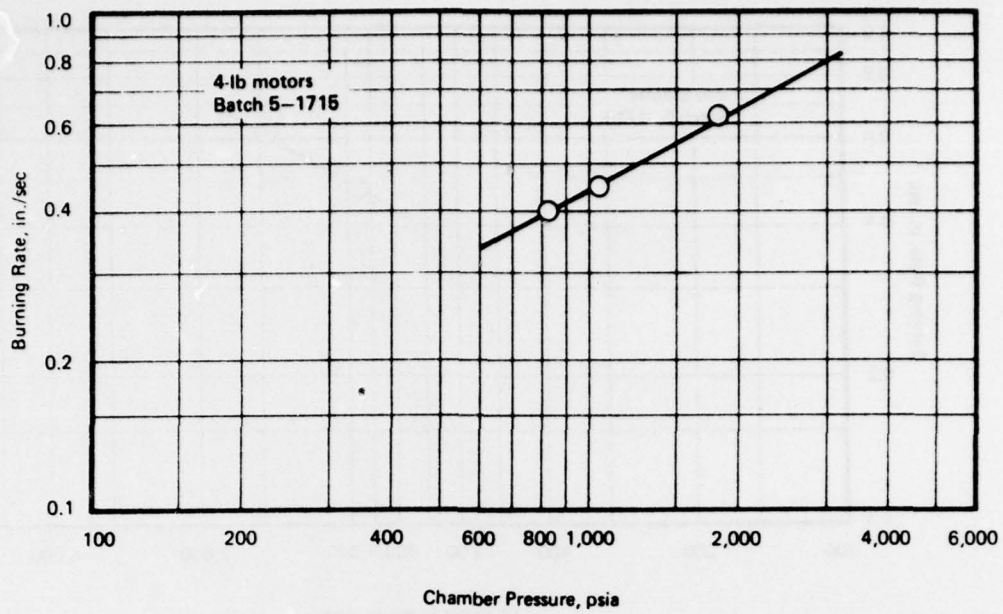
<u>NCO/OH</u>	<u>AP</u>		
	<u>65/35</u>	<u>60/40</u>	<u>55/45</u>
.86	5-1711	5-1712	5-1713
.83	5-1714	5-1715	5-1716
.80	5-1717	5-1718	5-1719

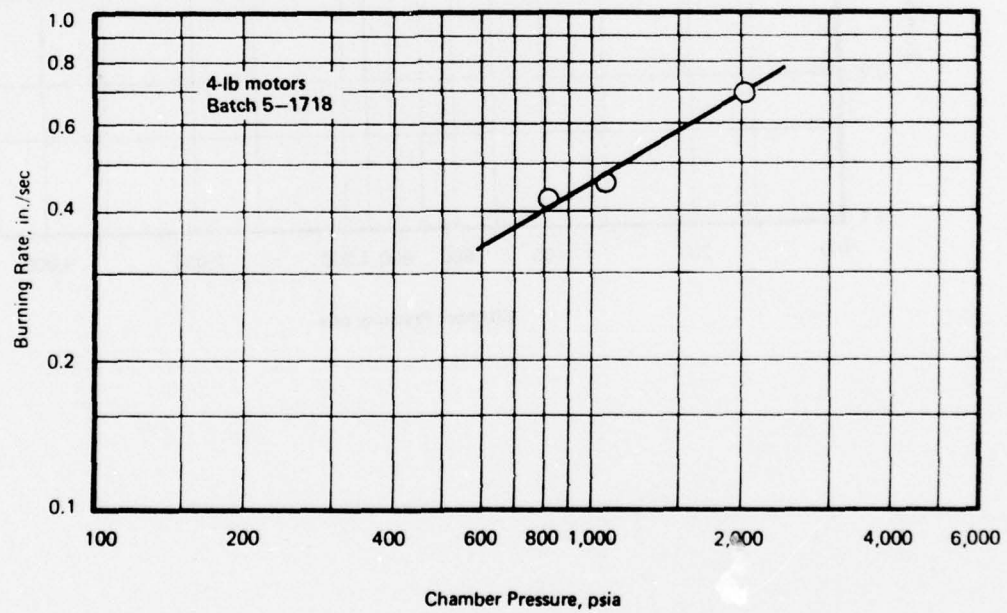
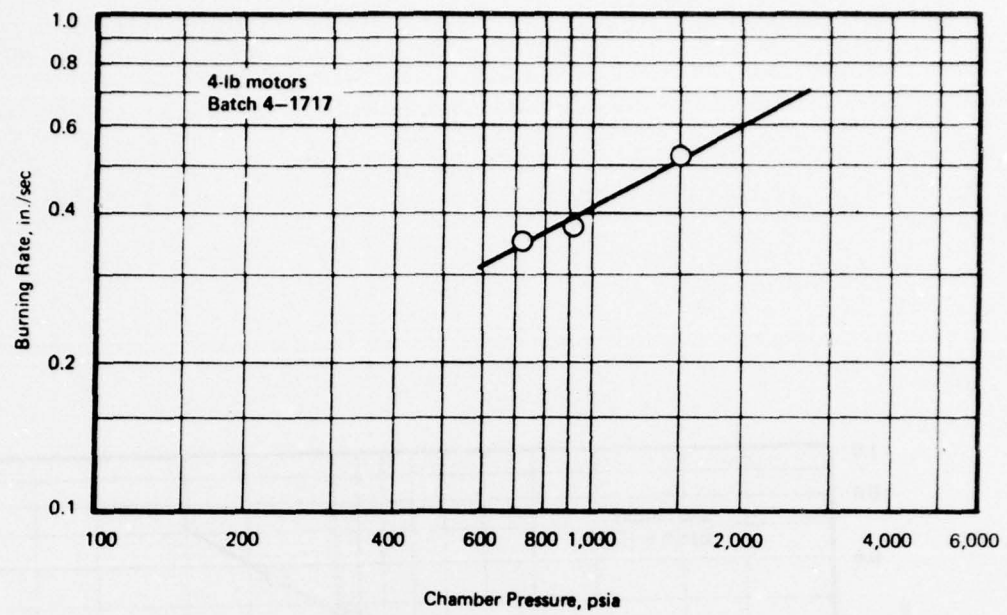
Motor Summary (2 x 4)

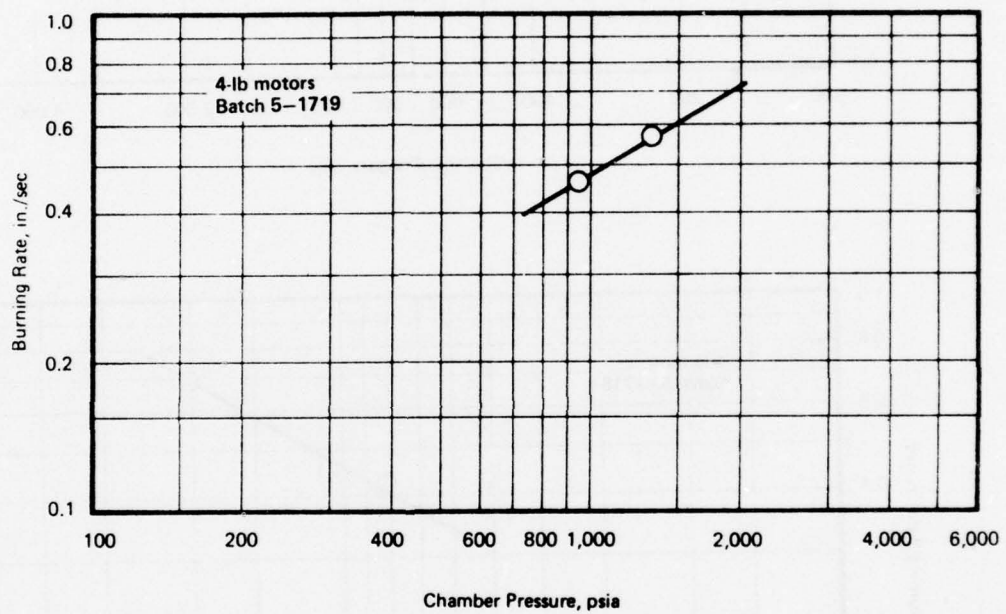
	<u>S/N</u>	<u>Web</u>	<u>P_c</u>	<u>r</u>
Batch 5-1711	10	.2503	1358	.507
	18	.2446	788	.412
	8	.2585	951	.424
Batch 5-1712	5	.2564	1798	.697
	3	.2481	895	.458
	16	.2437	1110	.502
Batch 5-1713	7	.2545	1067	.561
	14	.2559	2208	1.011
	9	.2474	1490	.697
Batch 5-1714	13	-	-	-
	10	.2518	1005	.485
	15	.2524	1703	.656
Batch 5-1715	2	.2415	1189	.495
	6	.2465	888	.448
	11	.2537	1998	.742
Batch 5-1716	19	.2544	2213	1.259
	27	.25	957	.506
	22	.25	1375	.635
Batch 5-1717	24	-	730	.387
	26	-	1409	.511
Batch 5-1718	1	.2455	1098	.504
	12	.2453	1235	.534
	4	.2525	830	.431
Batch 5-1719	20	-	986	.523
	21	-	1544	.859











SECTION 2.2
400-GALLON PREPRODUCTION BATCH
(BATCH 400-1450)

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 CHARACTERIZATION BATCH, 400-1450
 4 LB MOTOR DATA
 65/35 GRIND RATIO, 85 NCO/OH RATIO

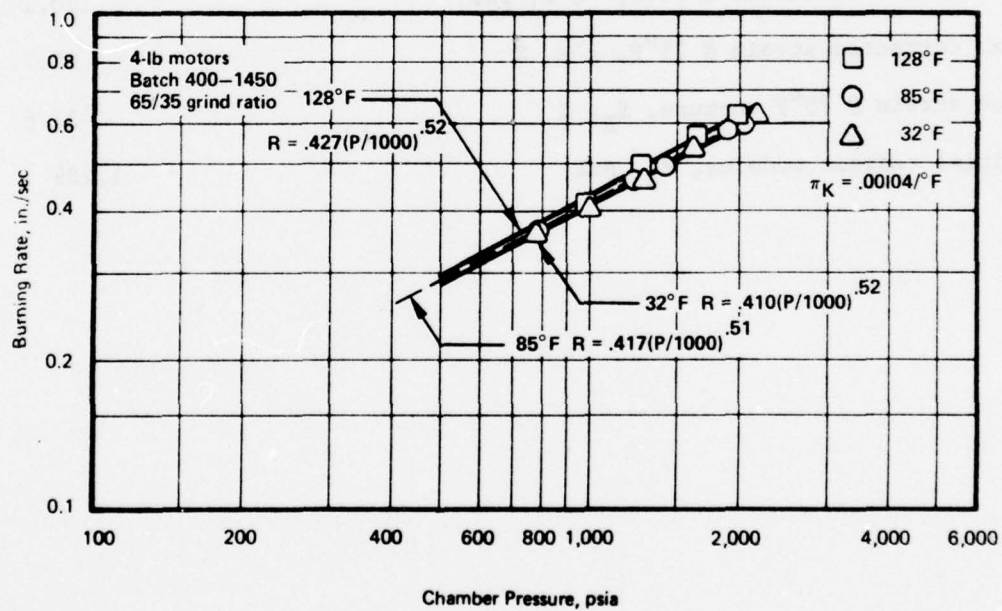
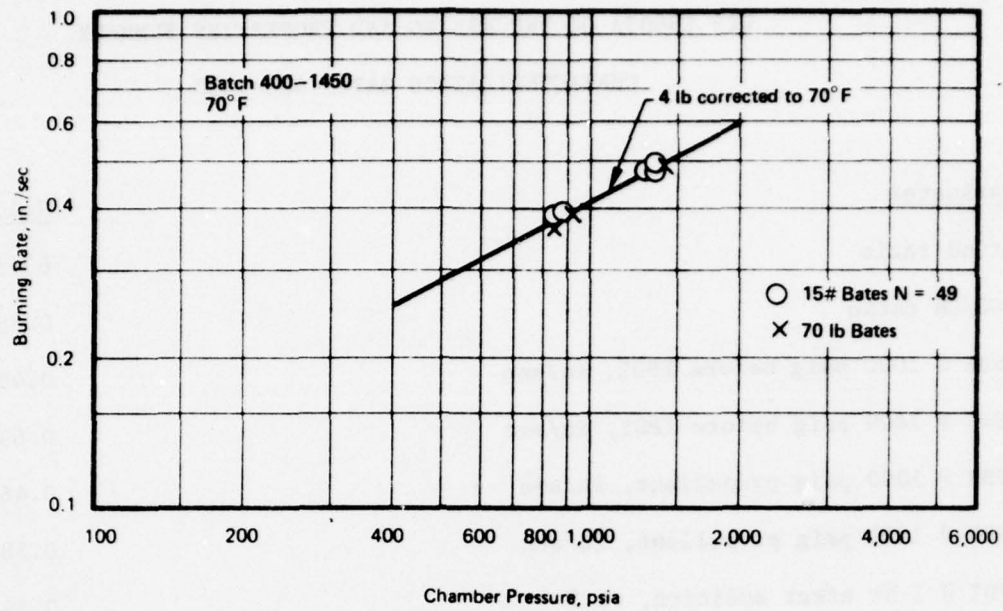
<u>Temperature, F</u>	<u>Chamber Pressure, psia</u>	<u>Burning Rate, in/sec</u>
32	2,165	0.6104
32	1,580	0.5339
32	1,276	0.4562
32	1,012	0.4110
32	789	0.3649
128	947	0.4148
128	1,299	0.4923
128	1,655	0.5675
128	1,989	0.6219
85	2,043	0.5950
85	1,895	0.5837
85	1,437	0.4906
85	1,238	0.4630
85	1,004	0.4177
85	802	0.3735
85	1,595	0.5358

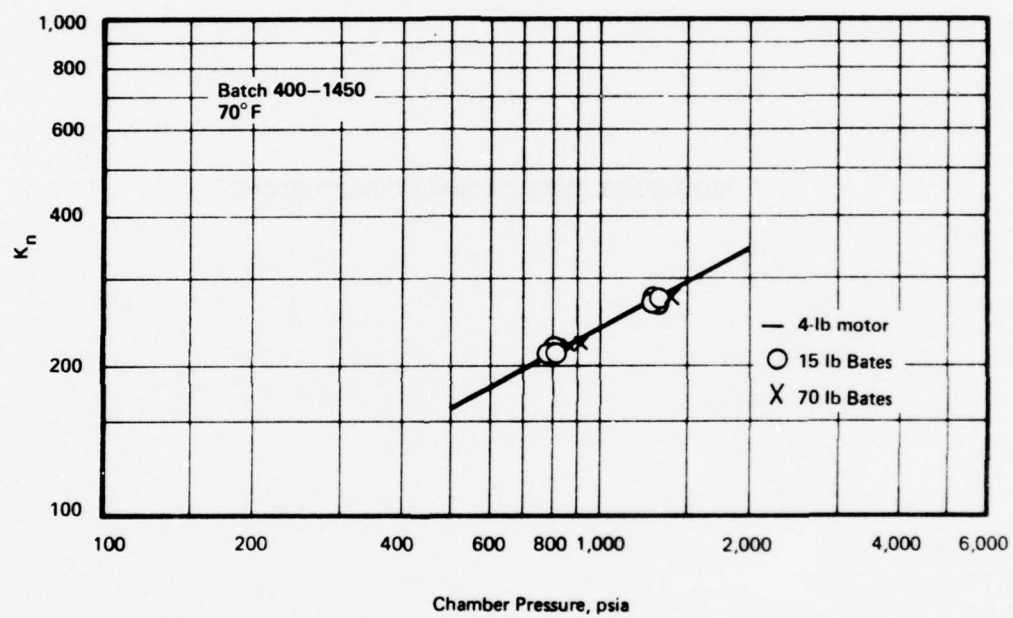
<u>Temperature, F</u>	<u>Composite r1000, in/sec</u>	<u>r1400, in/sec</u>	<u>Pressure Exponent</u>	<u>One Sigma, %</u>
32	0.410	0.489	0.522	1.70
128	0.427	0.514	0.550	0.44
85	0.416	0.494	0.510	1.19
π_K	0.104%/°F			
π_P	0.0498%/°F			

UTP 18803A QC PROCESSING AND PROPERTIES SUMMARY

CHARACTERIZATION BATCH 400-1450

<u>Parameter</u>	<u>Value</u>
Grind ratio	65/35
NCO/OH ratio	0.85
LSBR @ 1000 psig before IPDI, in/sec	0.499
LSBR @ 1400 psig before IPDI, in/sec	0.638
LSBR @ 1000 psig propellant, in/sec	0.467
LSBR @ 1400 psig propellant, in/sec	0.589
IPDI @ 1 hr after addition, wt %	0.39
Viscosity @ 1 hr after IPDI addition, Kp @ 5000 dynes/cm ²	6.98
Max. corrected stress @ 75°F, σ_m^c , psi	120.1
Max. corrected strain @ 75°F, ϵ_m^c , %	30.7
True strain @ 75°F rupture, E_R , %	31.6
Initial tangent modulus, E_o , psi	1,229





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SECTION 2.3

PRODUCTION RUN NO. 1

(BATCHES 400-1454 THROUGH 400-1465)

FIRST PRODUCTION CASTING

UTP-18, 803A DATA

Four Found Motor Data				12 LD Motor Data				70 Pound Data			
Batch	Chamber Pressure, psia	Burning Rate in/sec	Test Temperature, F	Burning Rate @ 1400 psia, in/sec	Exponent	Chamber Pressure, psia	Burning Rate in/sec	Test Temperature, F	Chamber Pressure, psia	Burning Rate in/sec	Test Temperature, F
1400-1454	Questionable P _c Data										
400-1455	1062	.4036	90	.454	.425	1162	.419	70	1231	.435	70
	1469	.4633	90								
400-1456	1061	.4011	90	.459	.486	800	.361	70	N/A	N/A	N/A
	1556	.4831	90								
400-1457	1021	.3943	90	.461	.493	1253	.479	70	1313	.471	70
	1403	.4612	90								
400-1458	1046	.410	90	.481	.55	831	.365	70	N/A	N/A	N/A
	1633	.524	90								
400-1459	1001	.3994	90	.471	.489	1268	.453	70	1371	.477	70
	1570	.4977	90								
400-1460	1054	.4161	90	.480	.504	895	.407	70	N/A	N/A	N/A
	1622	.5170	90								
400-1461	1083	.4137	90	.471	.504	1243	.444	70	Test motor hardware failed		70
	1572	.4991	90								
400-1462	1058	.4162	90	.479	.501	817	.373	70	N/A	N/A	N/A
	1706	.5287	90								
400-1463	966	.4049	90	.481	.466	1230	.446	70	Test motor hardware failed		70
	1653	.520	90								
400-1464	1015	.4031	90	.477	.523	833	.381	70	N/A	N/A	N/A
	1651	.520	90								
400-1465	1033	.4172	90	.487	.511	1251	.458	70	Test motor hardware failed		70
	1804	.5947	90								

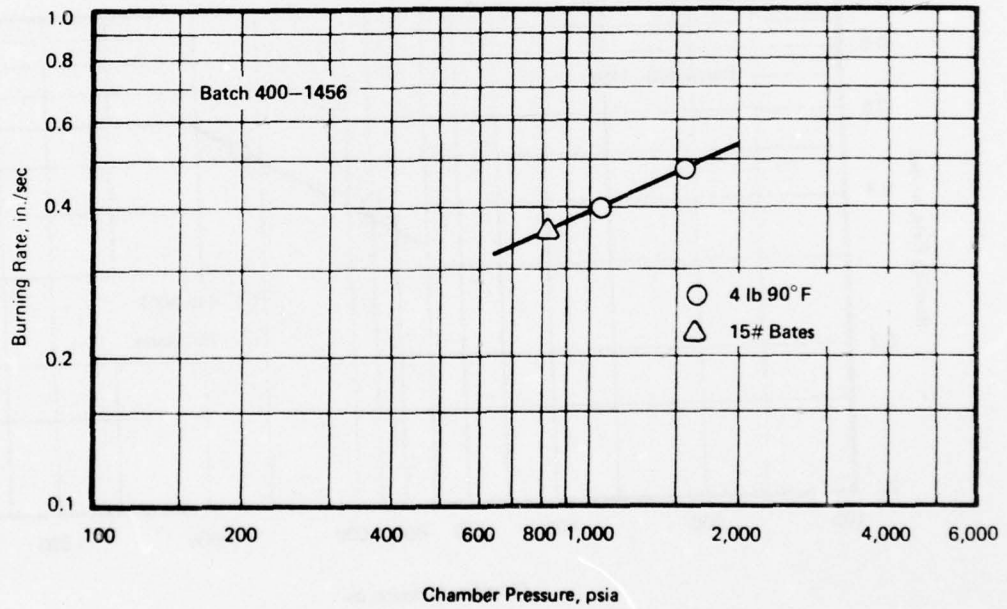
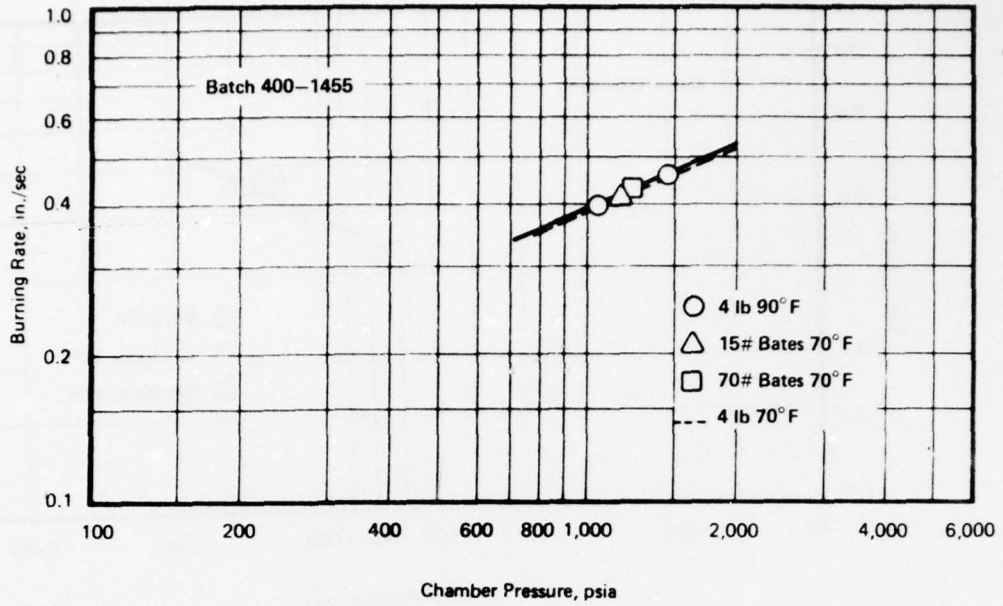
FIRST PRODUCTION CASTING

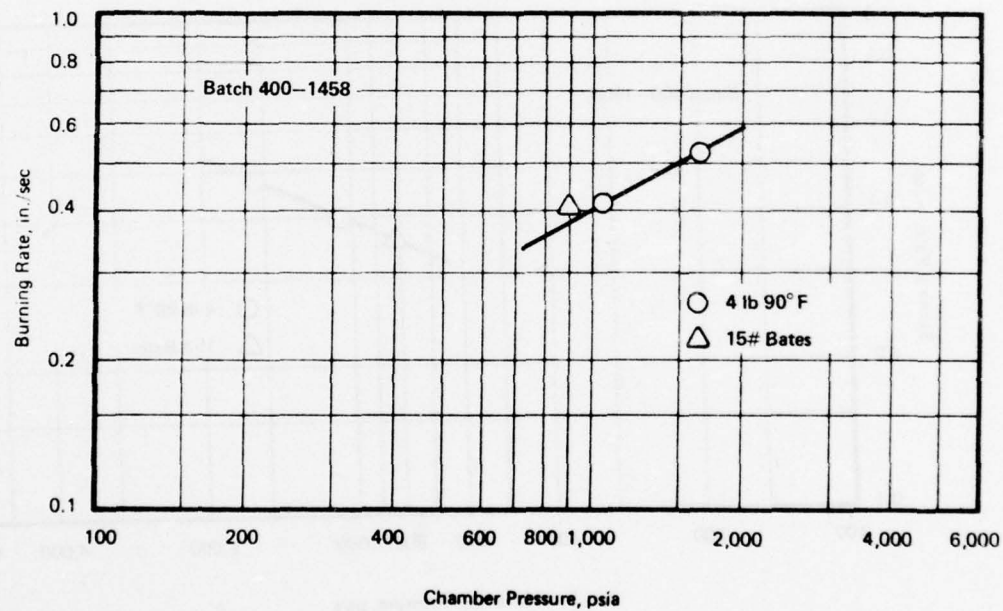
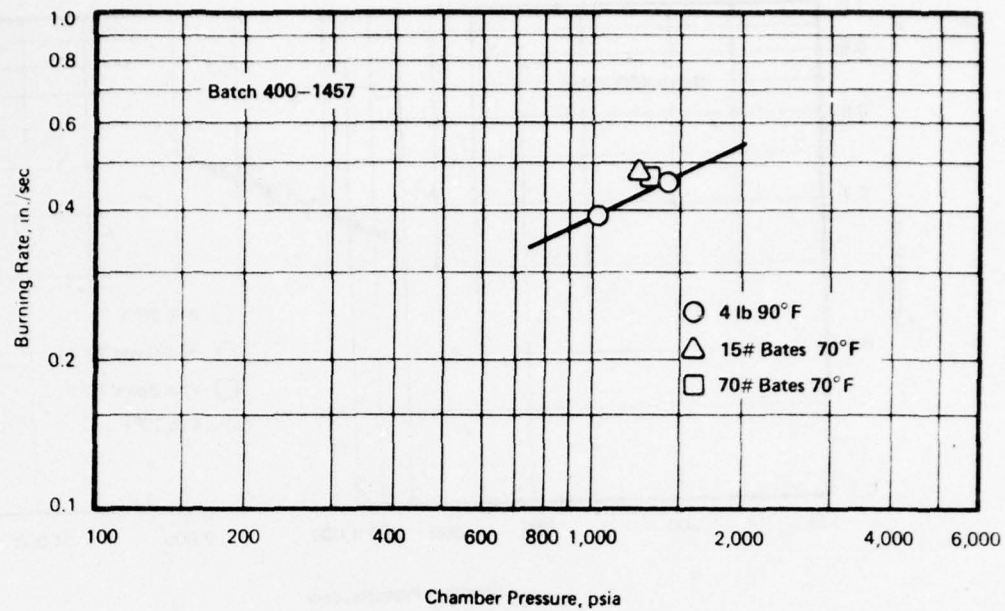
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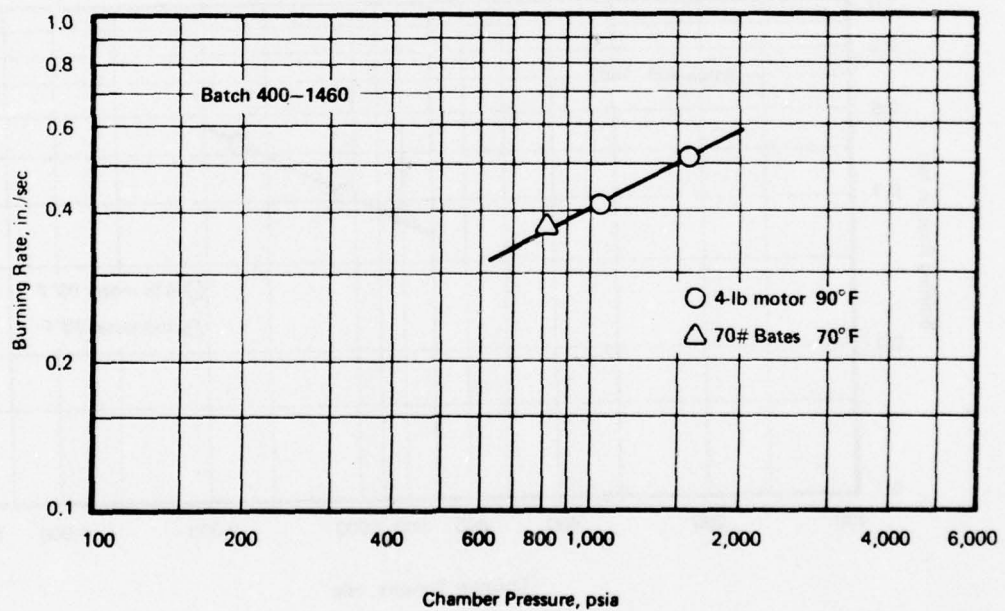
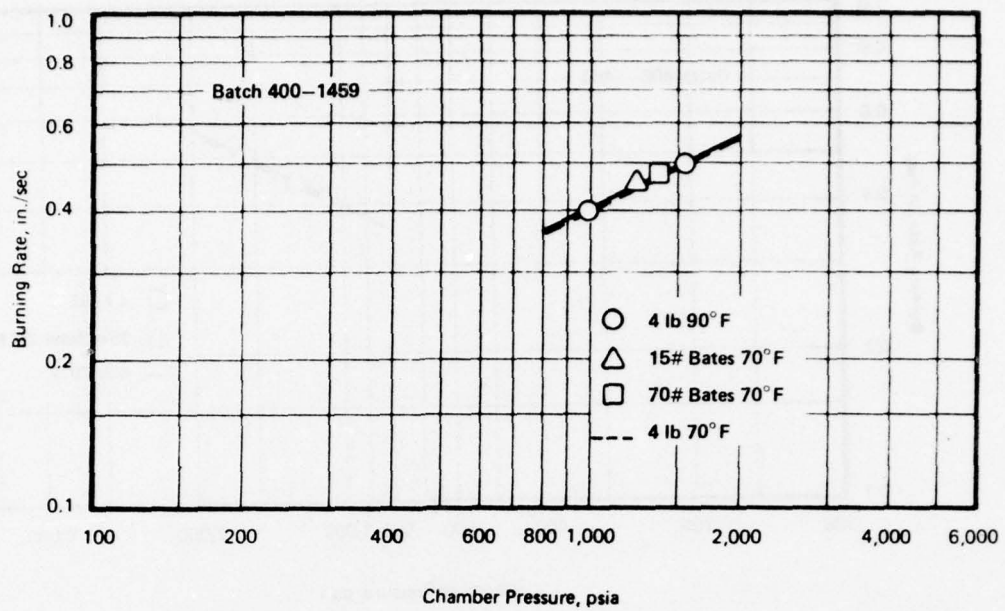
Batch 400-	Grind Ratio	LSBR Before		LSBR After		Four Pound Motor Data		Exponent
		1000 psig	IPDI, in/sec 1400 psig	1000 psig	IPDI, in/sec 1400 psig	R 1000, in/sec	R 1400 in/sec	
1454	70/30	.467	.589	.444	.558	Questionable pc data		
1455	70/30	.467	.595	.445	.554	.393	.454	.425
1456	68/32	.473	.600	.447	.564	.390	.459	.486
1457	68/32	.469	.598	.445	.553	.390	.461	.493
1458	66/34	.473	.607	.449	.568	.400	.481	.55
1459	66/34	.476	.617	.455	.572	.399	.471	.489
1460	66/34	.483	.619	.460	.587	.405	.480	.504
1461	66/34	.483	.617	.456	.583	.397	.471	.504
1462	65/35	.483	.631	.459	.587	.405	.479	.501
1463	65/35	.481	.624	.456	.581	.411	.481	.466
1464	66/34	.482	.614	.457	.576	.400	.477	.523
1465	66/34	.488	.620	.459	.587	.410	.487	.511
6 batches	66/34	---	---	---	---	.402	.478	.518

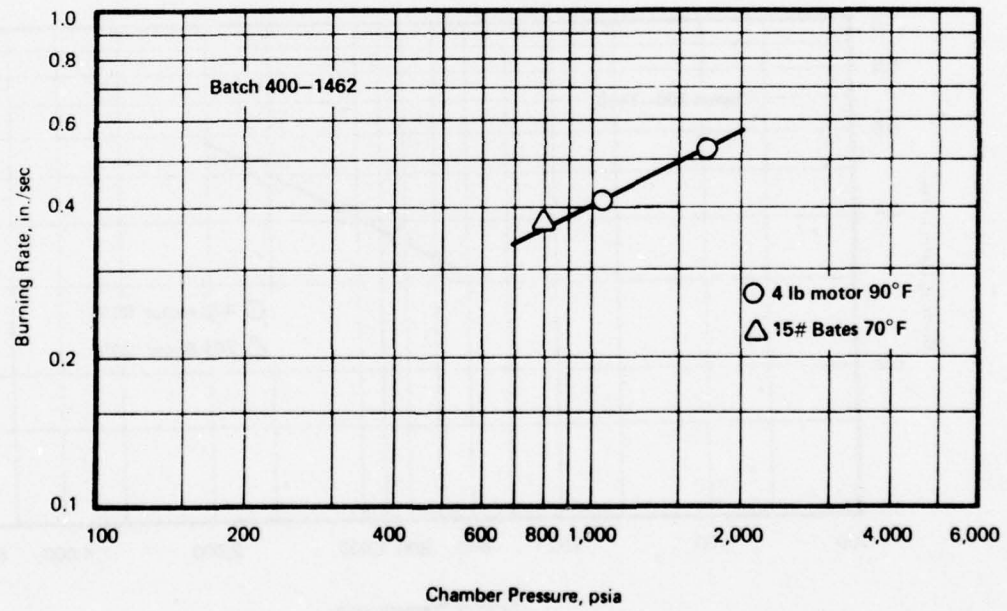
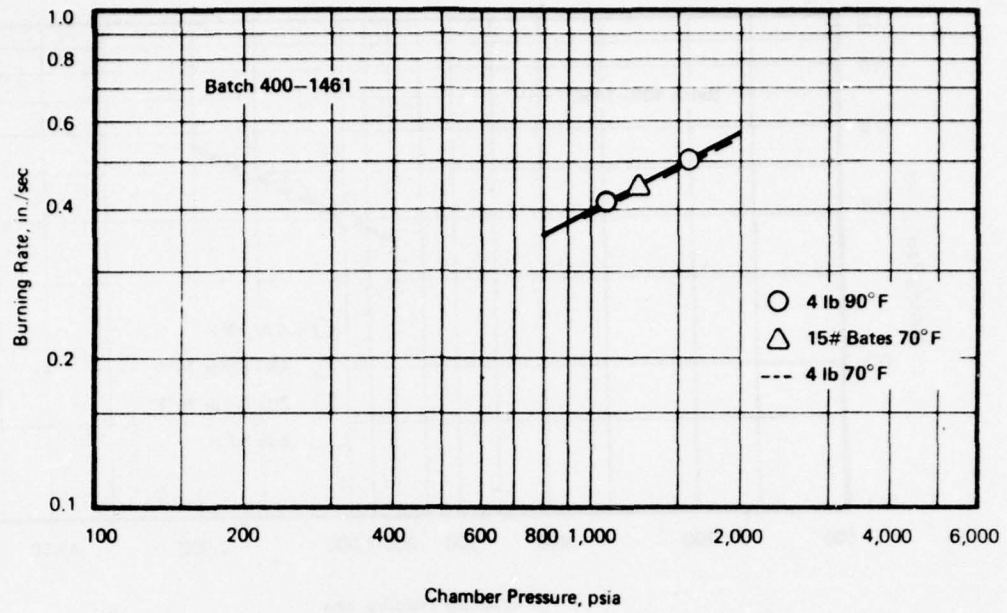
UTP 18803A QC PROCESSING AND PROPERTIES SUMMARY
FIRST PRODUCTION CASTING

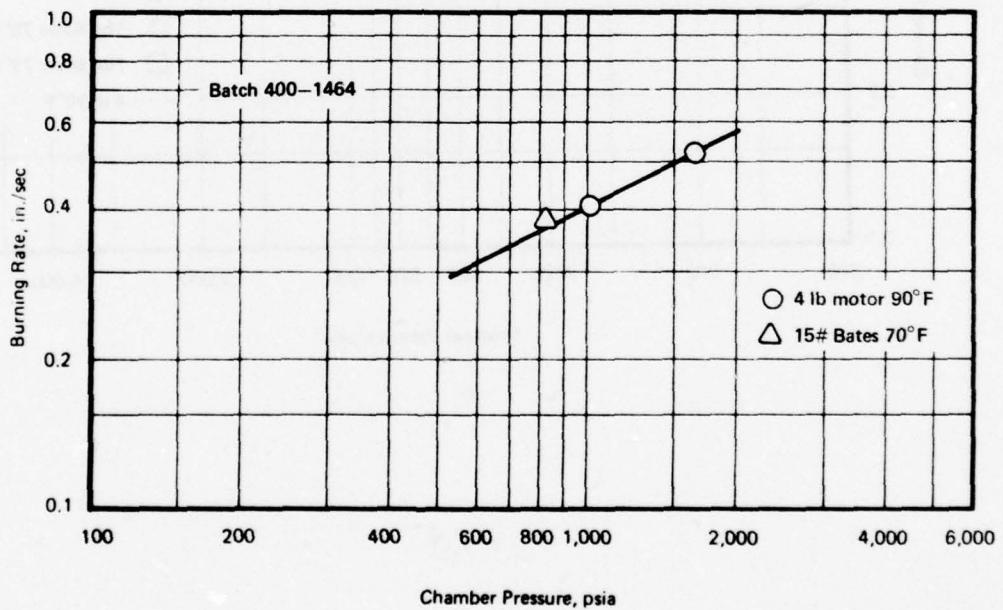
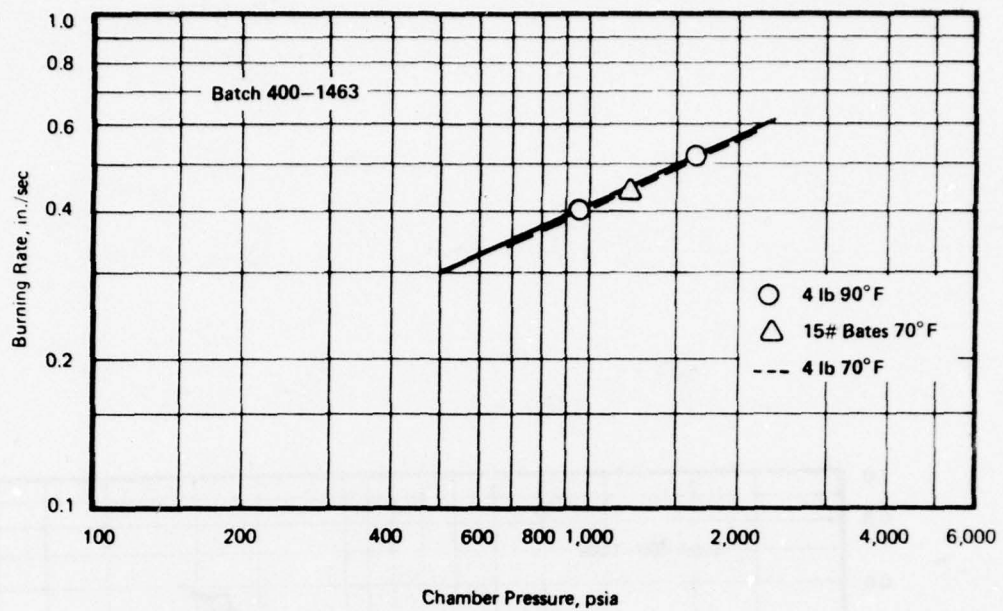
Parameter	1454	1455	1456	1457	1458	1459	1460	1461	1462	1463	1464	1465	\bar{X}	Sx
Grind ratio	70/30	70/30	68/32	68/32	66/34	66/34	66/34	66/34	65/35	65/35	66/34	66/34		
NCO/OH	0.85													
Fuel premix number	3500-1													
IPDI @ 1 hr after addition, wt %	0.38	0.38	0.40	0.37	0.38	0.37	0.37	0.37	0.38	0.38	0.37	0.38	0.38	0.0087
Viscosity @ 1 hr after IPDI 2 addition, Kp @ 5000 dynes/cm ²	5.0	4.7	4.2	4.1	4.5	4.8	4.8	4.8	5.7	5.5	6.5	5.3	4.99	0.0067
Max. corrected stress @ 75°F, σ _c , psi	126	128	123	115	90	118	131	131	120	107	110	135	120	12.8
Max. corrected strain @ 75°F, ε _c , %	43	40	40	37	28	37	40	38	40	32	38	33	37.2	4.22
True strain @ 75°F rupture, E _r , %	44	41	42	38	29	38	41	39	41	32	39	34	38.2	4.41
Initial tangent modulus, E _o , psi	408	587	432	658	312	399	393	460	526	411	555	468	467	97.3

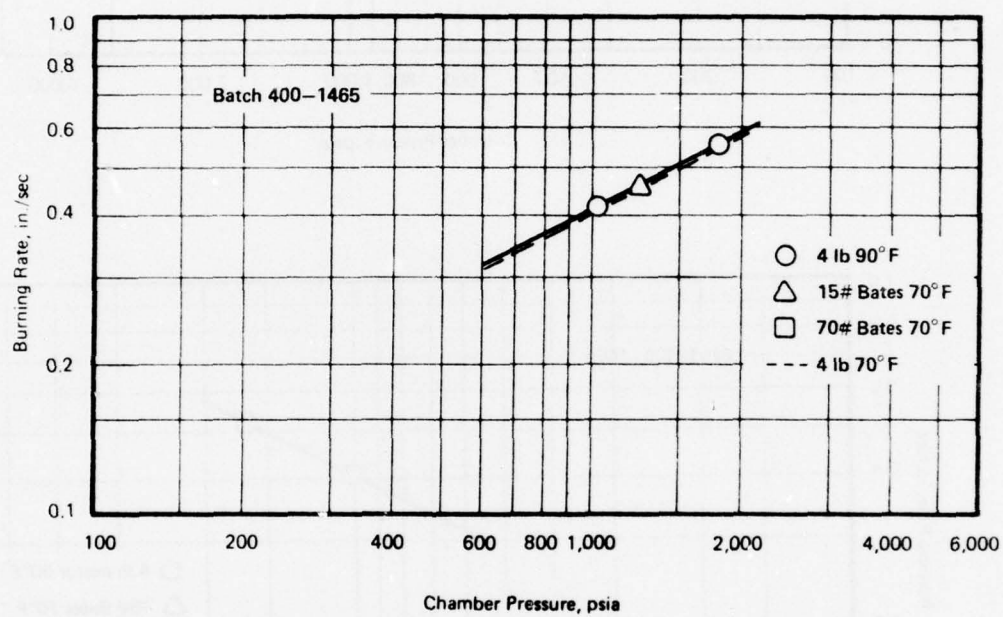


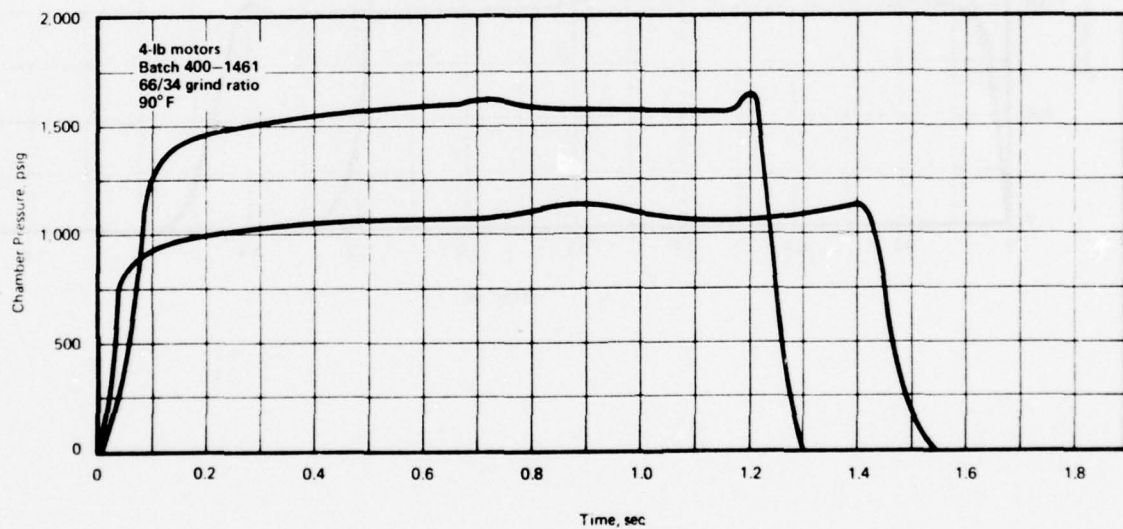
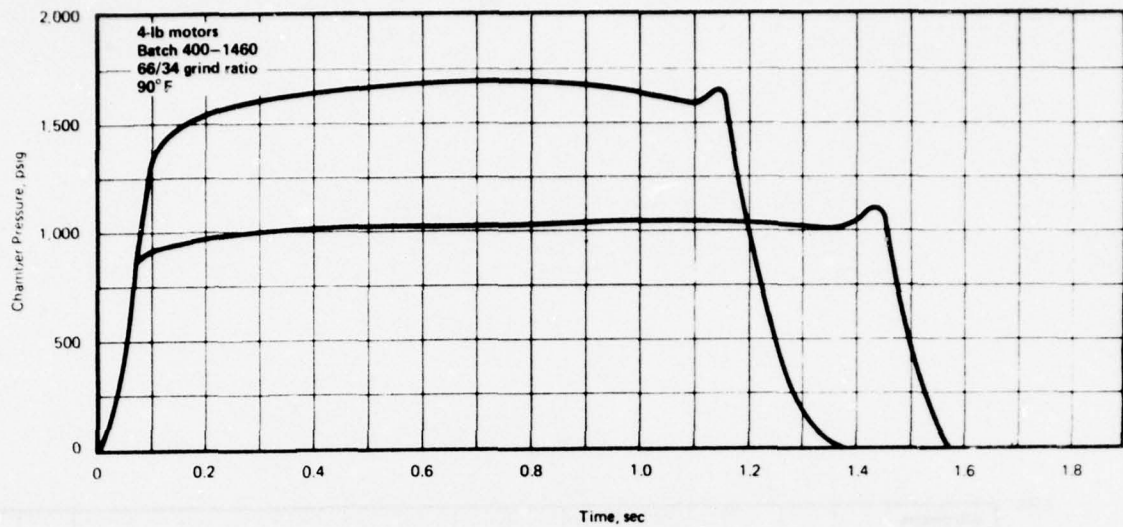


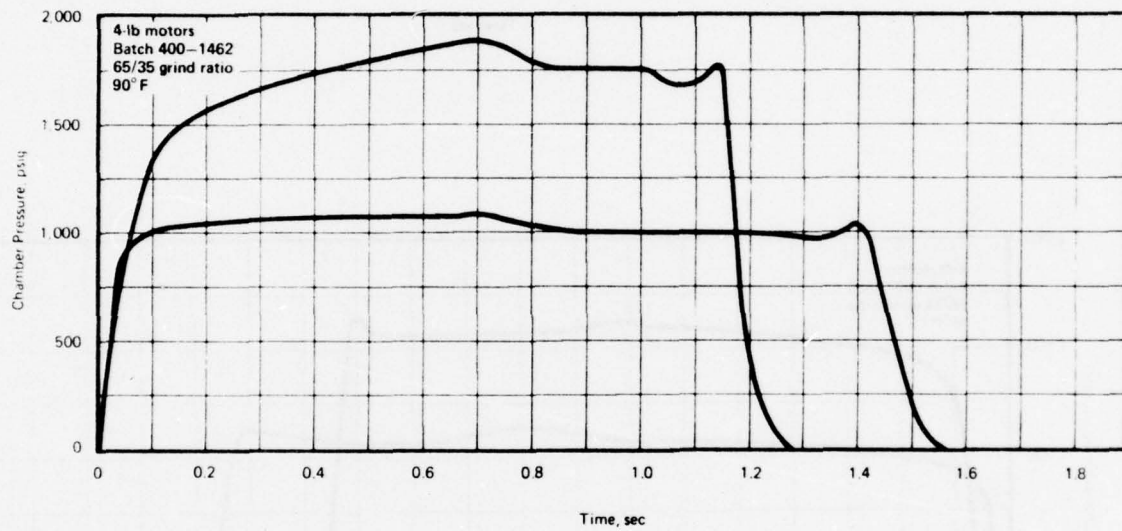












SECTION 2.4
PRODUCTION RUN NO. 2
(BATCHES 400-1468 THROUGH 400-1479)

SECOND PRODUCTION CASTING, 65/35 GRIND RATIO
 UTP-18, 803A 4-LB MOTOR DATA, 90°F
 AVERAGE WEB THICKNESS

All Data			800 thru 1800 Psia			1000 & 1500			1000 Psia to 2200 Psia			800 & 1000 Psia		
Three Points			Three Points			Two Data Pts			Three Points			Two Data Pts		
\bar{n}	\bar{F}	$\bar{G}, \%$	\bar{n}	\bar{F}	$\bar{G}, \%$	\bar{n}	\bar{F}	$\bar{G}, \%$	\bar{n}	\bar{F}	$\bar{G}, \%$	\bar{n}	\bar{F}	$\bar{G}, \%$
.513	.416 .494 .546	3.1	.488	.415 .490 .538	3.5	.602	.397 .487 .547		.602	.398 .486 .545	0.4	.214	.403 .433 .451	
.564	.412 .498 .556	1.0	.55	.412 .496 .552	1.0	.58	.408 .495 .554		.584	.407 .496 .556	0.1	.451	.408 .475 .519	
.561	.421 .508 .566	1.9	.547	.420 .505 .562	2.2	.618	.408 .507 .566		.604	.409 .501 .564	0.4	.37	.416 .472 .507	
.526	.421 .503 .557	0.5	.515	.421 .500 .553	0.2	.524	.420 .501 .554		.536	.419 .501 .557	0.3	.50	.420 .497 .548	
.516	.419 .499 .551	2.6	.470	.418 .490 .537	2.4	.568	.405 .490 .548			.404 .492 .552	0.5		.410 .455 .483	
.567	.414 .502 .560	2.0	.569	.415 .502 .561	2.4	.633	.403 .499 .564		.612	.404 .497 .559	0.9	.315	.405 .450 .478	
.551	.410 .494 .549	1.9	.512	.409 .486 .536	1.3	.55	.403 .486 .540		.586	.402 .489 .548	1.1	.404	.403 .460 .498	
.491	.415 .490 .539	1.8	.491	.415 .490 .539	1.8	.54	.406 .487 .541			Only Three Points		.362	.410 .463 .496	
.465	.417 .488 .534	1.1	.489	.417 .492 .541	0.7	.518	.413 .492 .544		.466	.417 .488 .534	1.3	.441	.415 .482 .525	

400-1477 84 In Char	.55	.419 .504 .561	3.1	.481 .492 .540	1.8	.543	.409 .491 .545	.612	.495 .558	1.9	.353	.413 .467 .501
400-1478 84 In Char	.569	.417 .505 .565	3.1	.496 .493 .542	1.4	.542	.409 .491 .546	.625	.404 .498 .563	2.5	.381	.412 .468 .504
400-1479 84 In Char	.514	.425 .505 .558	2.1	.514 .505 .558	2.1	.588	.412 .502 .562	Only Two Points				.419 .476 .512
400-1468-1476	.537	.416 .498 .554	2.1	.516 .494 .547	2.14	.574	.406 .493 .552				.378	

UTP-18803A 65/35 GRIND RATIO
SECOND PRODUCTION CASTING
90° F FOUR POUND MOTOR

<u>Batch</u>	<u>Burning Rate In/Sec/Chamber Pressure (psia)</u>			
400-1468	.3854 812	.406 1036	.5389 1657	.6206 2070
400-1469	.3761 833	.411 1014	.5432 1640	.6525 2235
400-1470	.393 856	.4292 1086	.5757 1747	.6749 2301
400-1471	.3768 804	.435 1071	.5322 1574	.6299 2133
400-1472	.3807 790	.415 1043	.5206 1555	.6145 2032
400-1473	.3827 838	.4060 1011	.568 1717	.6178 2024
400-1474	.3616 771	.3971 972	.5215 1594	.6472 2229
400-1475	.3783 803	.4163 1046	.5646 1843	
400-1476	.3781 808	.4294 1078	.5334 1639	.5974 2002
400-1477	.3815 804	.4221 1062	.5405 1674	.6780 2289
400-1478	.3828 823	.4175 1037	.5392 1662	.6686 2176
400-1479	.3878 814	.4331 1090	.5666 1722	

18803A SECOND PRODUCTION CASTING

<u>Batch</u>	<u>Before IPDI</u>		<u>After IPDI</u>	
	<u>1000</u>	<u>1400</u>	<u>1000</u>	<u>1400</u>
400-1468	.495	.63	.462	.589
400-1469	.492	.63	.562	.586
400-1470	.494	.63	.464	.586
400-1471	.487	.623	.458	.577
400-1472	.496	.638	.463	.587
400-1473	.495	.638	.468	.598
400-1474	.495	.641	.464	.595
400-1475	.486	.626	.462	.583
400-1476	.488	.630	.460	.585
400-1477	.487	.628	.465	.585
400-1478	.487	.630	.457	.587
400-1479	.490	.639	.465	.596

UTP-18,803A QC PROCESSING AND PROPERTIES SUMMARY
SECOND PRODUCTION CASTING

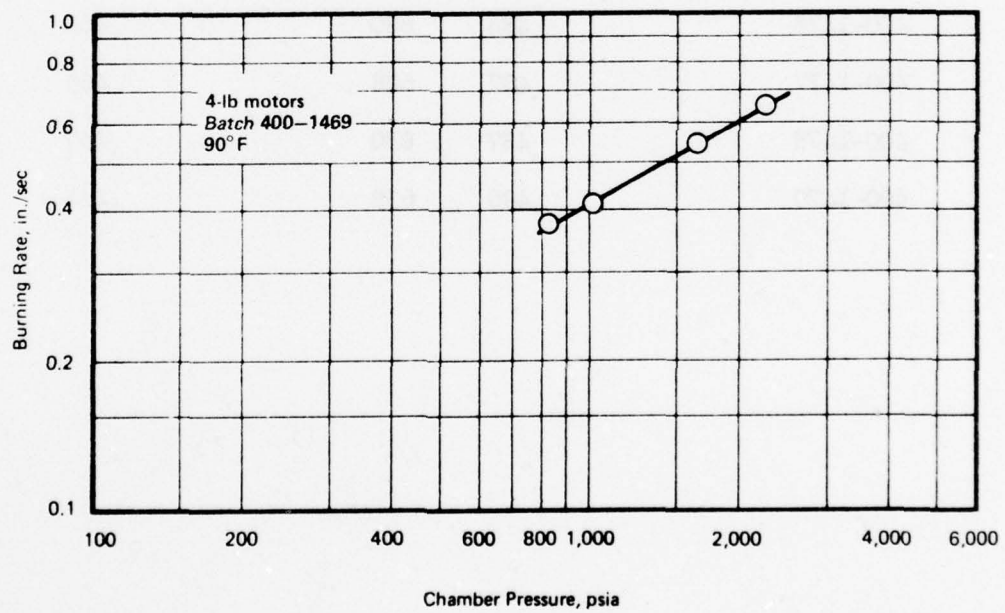
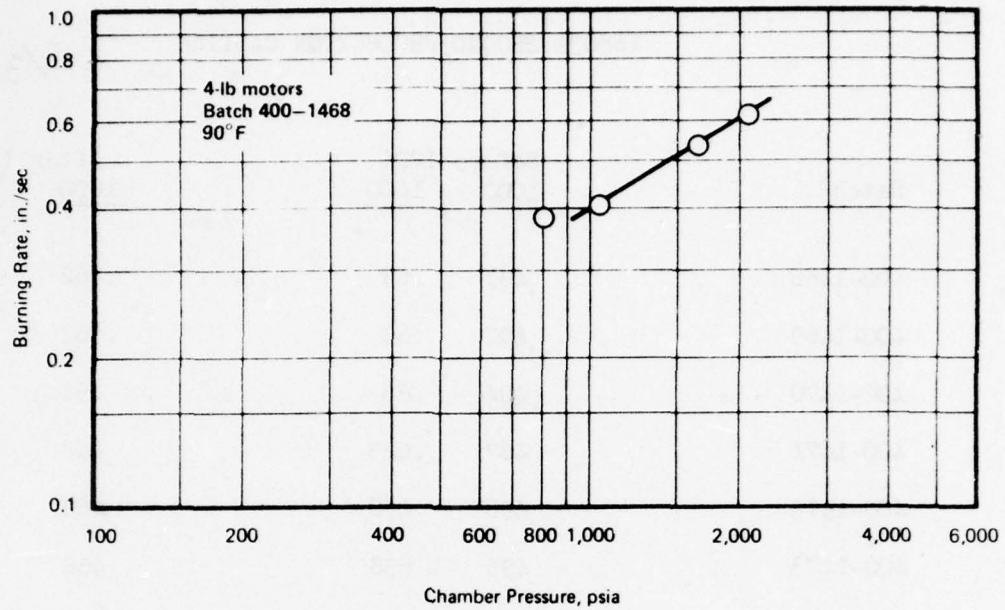
Parameter	1468	1469	1470	1471	1472	1473	1474	1475	1476	1477	1478	1479	\bar{x}	Sx
Grind ratio	65/35													
NCO/OH	0.85													
Fuel premix number	3500-2													
IPDI @ 1 hr after addition, wt %	0.37	0.37	0.38	0.37	0.37	0.37	0.37	0.38	0.37	0.38	0.38	0.38	0.374	0.005
Viscosity @ 1 hr after IPDI 2 addition, Kp @ 5000 dynes/cm ²	7.8	6.4	5.8	6.0	9.0	7.9	6.6	5.6	5.5	5.8	5.6	6.8	6.57	1.12
Max. corrected stress @ 75°F, σ_{cm} , psi	133	137	141	126	122	121	124	114	120	112	127	117	125.0	8.90
Max. corrected strain @ 75°F, ϵ_{cm} , %	29	29	35	29	24	25	32	29	27	30	34	25	29.8	3.61
True strain @ 75°F rupture, E_r , %	30	30	36	30	26	25	32	29	28	31	35	26	29.8	3.41
Initial tangent modulus, E_o , psi	999	1081	833	779	967	925	720	846	570	740	572	816	821	158.0

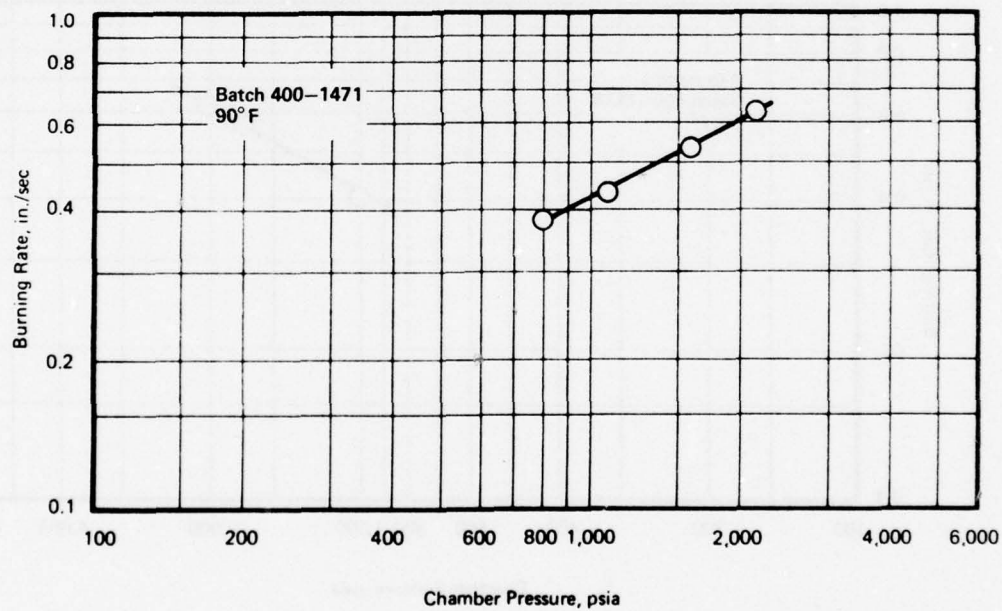
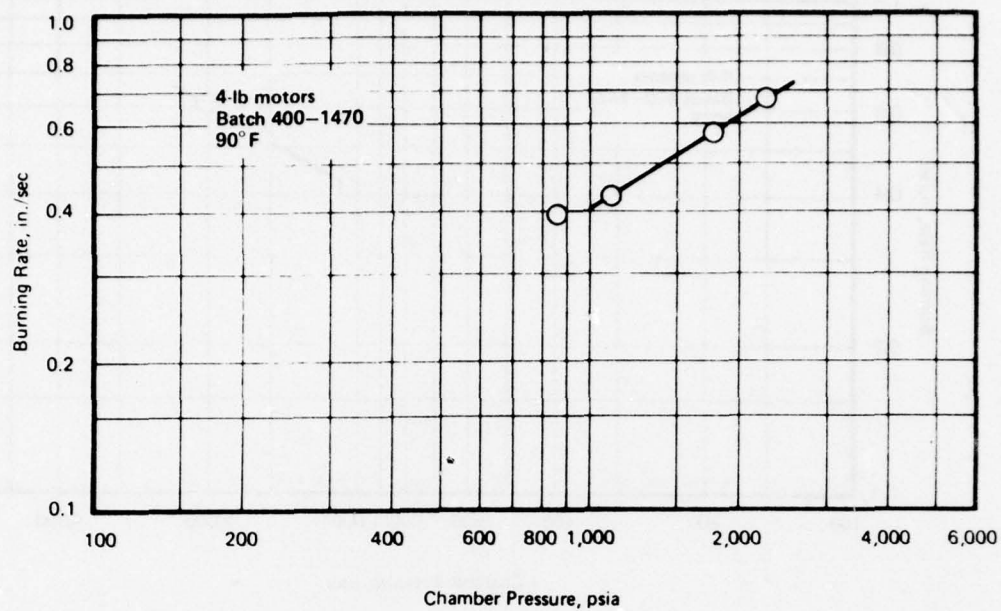
Cartridges lost in 23 May 76 fire

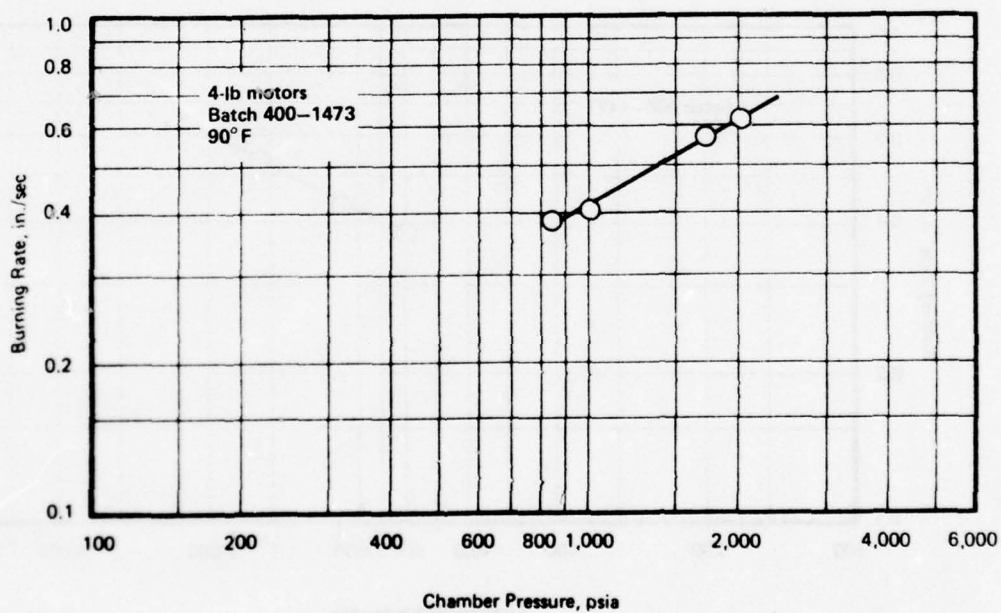
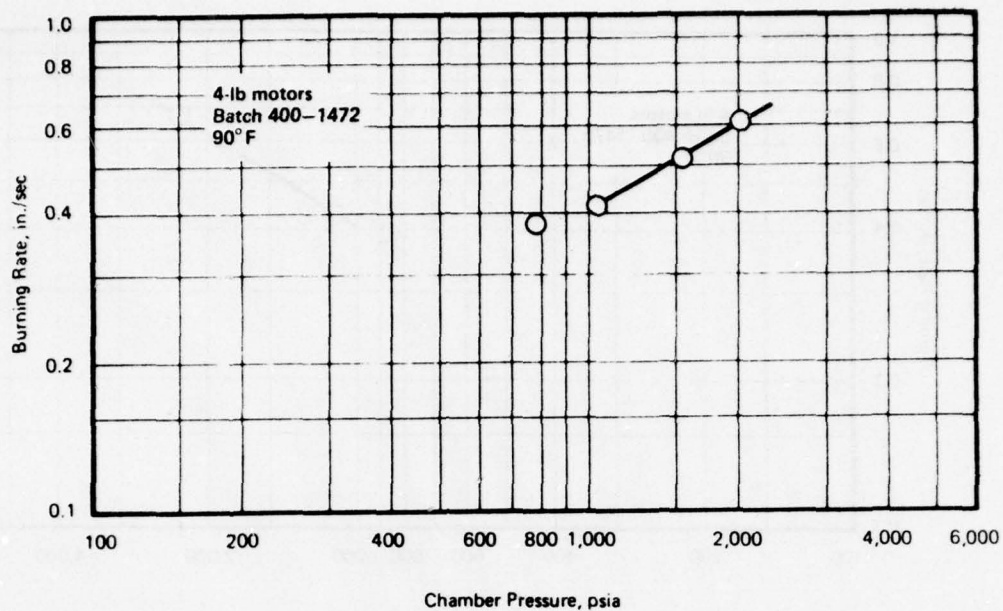
18803A SECOND PRODUCTION CASTING

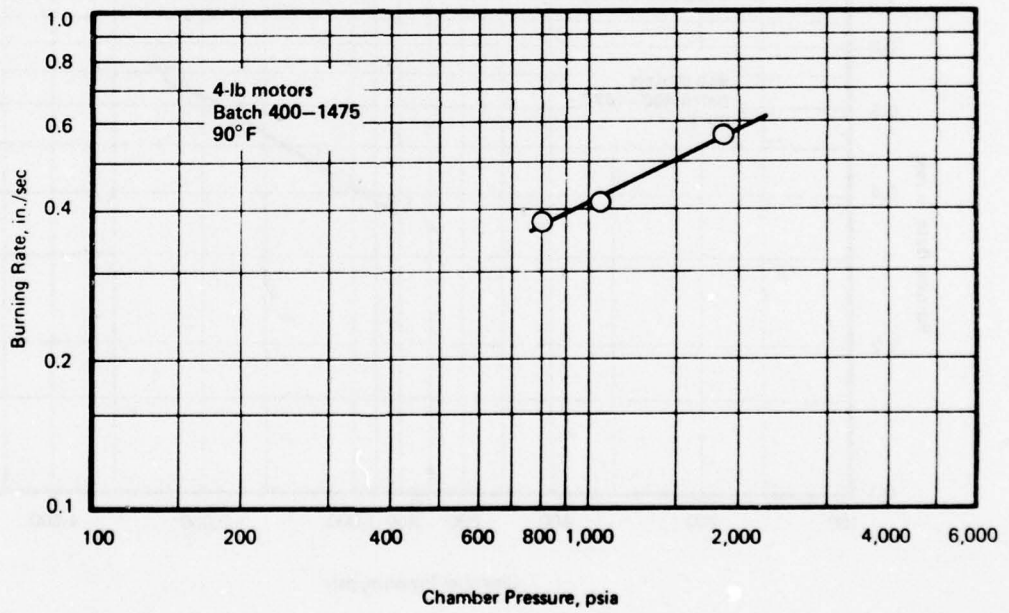
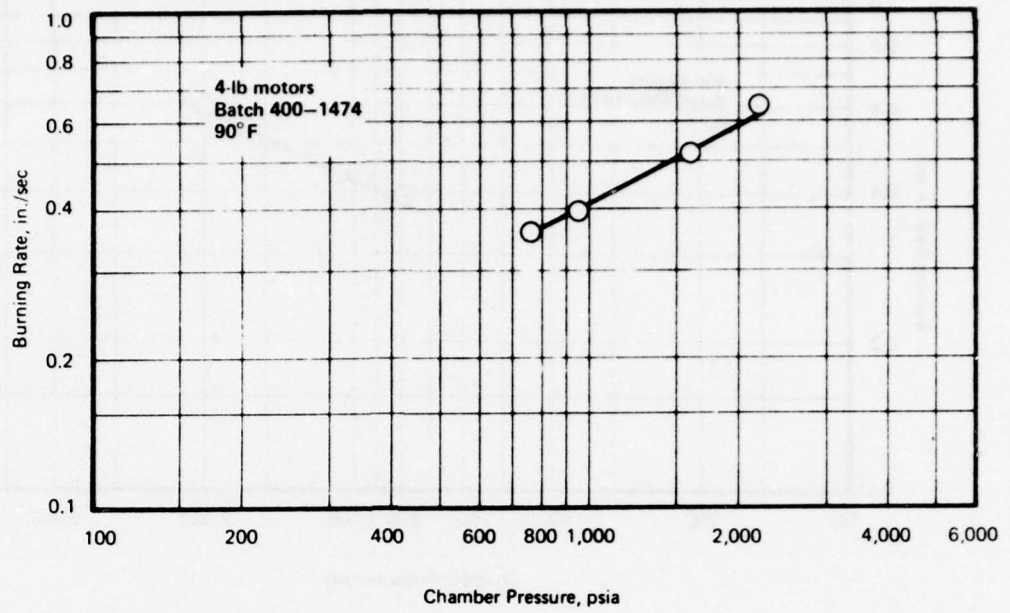
65/35

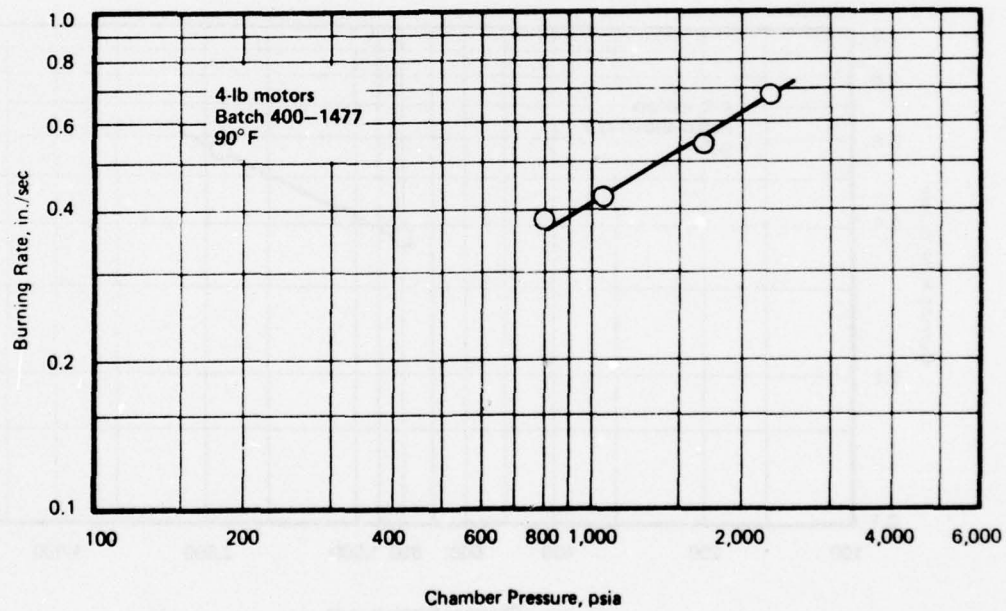
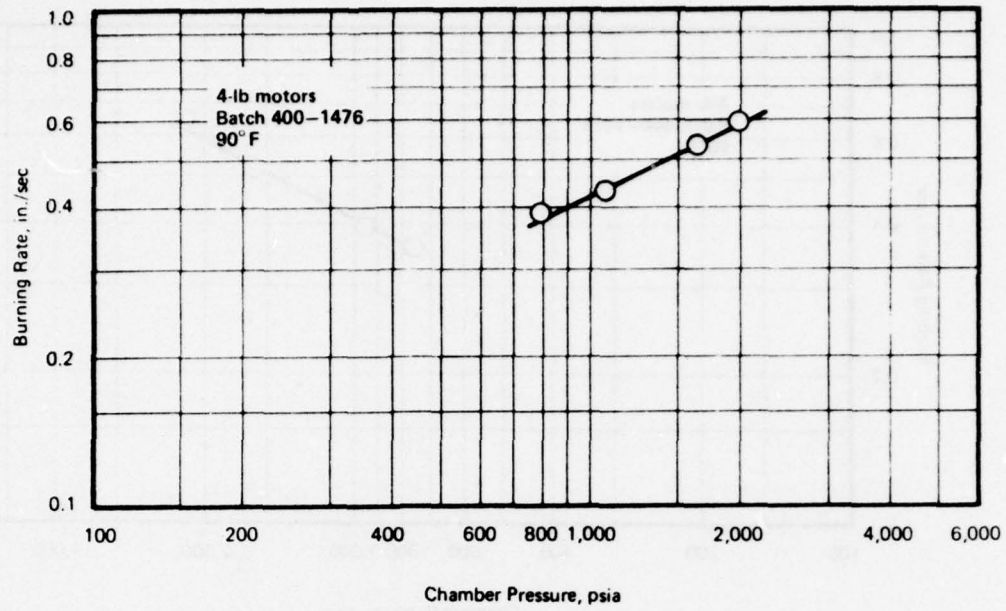
<u>Batch</u>	<u>Before IPDI</u>		<u>After IPDI</u>	
	<u>1000</u>	<u>1400</u>	<u>1000</u>	<u>1400</u>
400-1468	.495	.63	.462	.589
400-1469	.492	.63	.562	.586
400-1470	.494	.63	.464	.586
400-1471	.487	.623	.458	.577
400-1472	.496	.638	.463	.587
400-1473	.495	.638	.468	.598
400-1474	.495	.641	.464	.595
400-1475	.486	.626	.462	.583
400-1476	.488	.630	.460	.585
400-1477	.487	.628	.465	.585
400-1478	.487	.630	.457	.587
400-1479	.490	.639	.465	.596

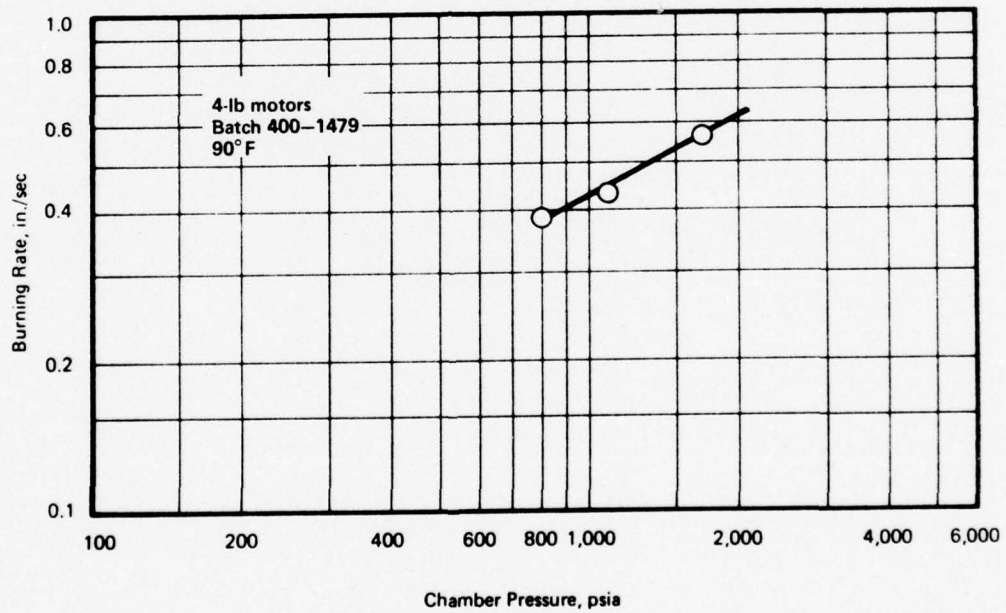
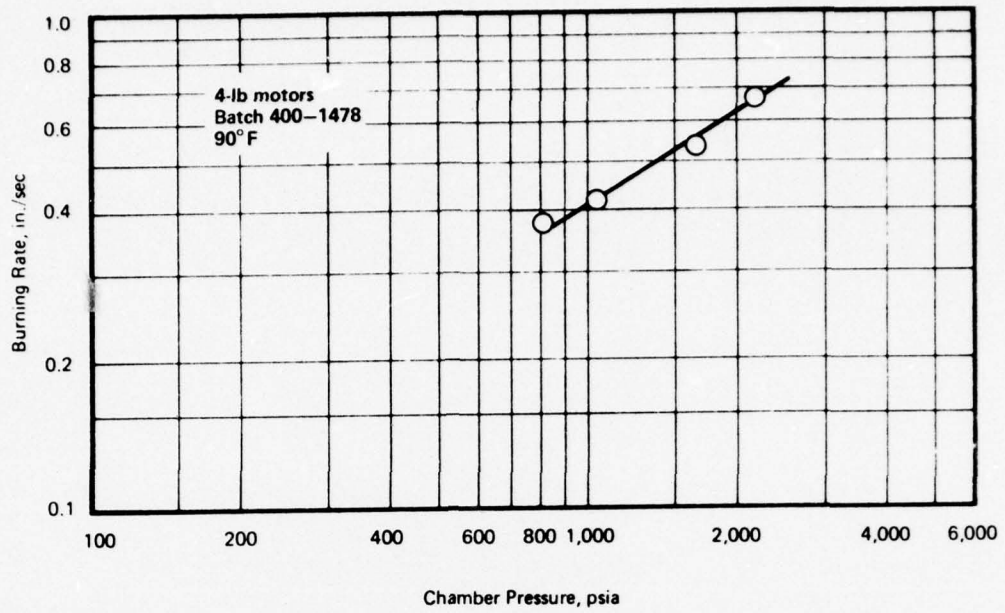












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SECTION 2.5
PRODUCTION RUN NO. 3
(BATCHES 400-1480 THROUGH 400-1491)

THIRD PRODUCTION CASTING. UTP-18, 803A

1000 thru 1700 psia

THIRD PRODUCTION CASTING
 UTP 18803A BATCHES 400-1480-1491
 FOUR MOTOR DATA 90 F

Batch 400-	<u>BURNING RATE, IN/SEC/CHAMBER PRESSURE, psia</u>			
1480	0.3998/1024	0.5007/1521		
1481	0.4037/966	0.4809/1350		
1482	0.4024/974	0.4962/1387		
1483	0.4039/952	0.4863/1383		
1484	0.3714/768	0.4091/1014	0.4809/1398	0.5377/1638
1485	0.3681/759	0.4214/1074	0.4829/1398	0.5366/1683
1486	0.3615/736	0.4379/1118	0.5165/1512	0.5538/1738
1487	0.3792/816	0.4207/1088	0.4869/1436	
1488	0.3747/792	0.4323/1085	0.4979/1475	
1489	0.3821/812	0.436/1118	0.4971/1481	
1490	0.3862/848	0.4348/1124	0.5022/1438	
1491	0.4025/872	0.4282/1115	0.5026-1490	

UTP-18,803A QC PROCESSING AND PROPERTIES SUMMARY
THIRD PRODUCTION CASTING

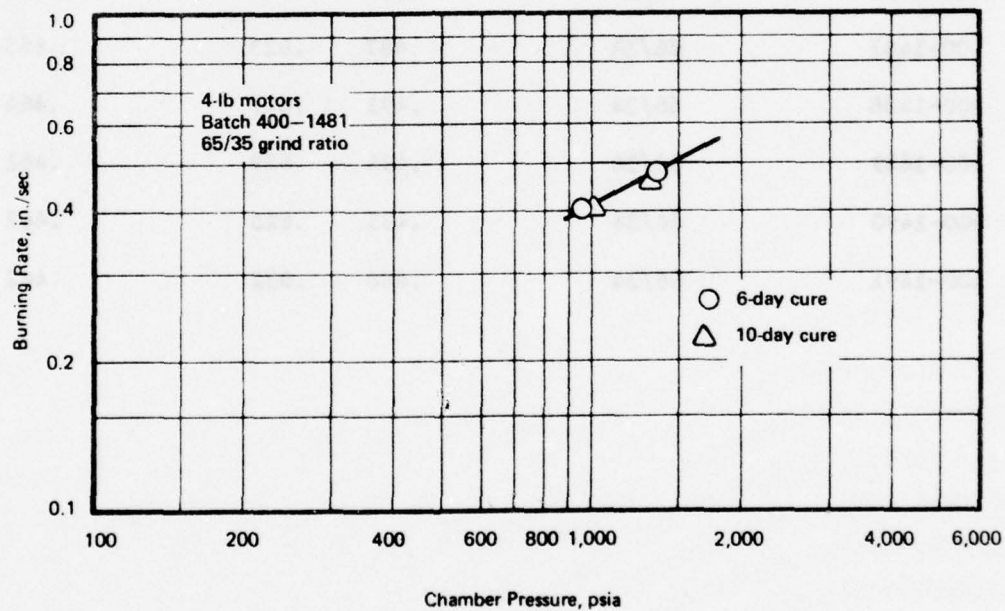
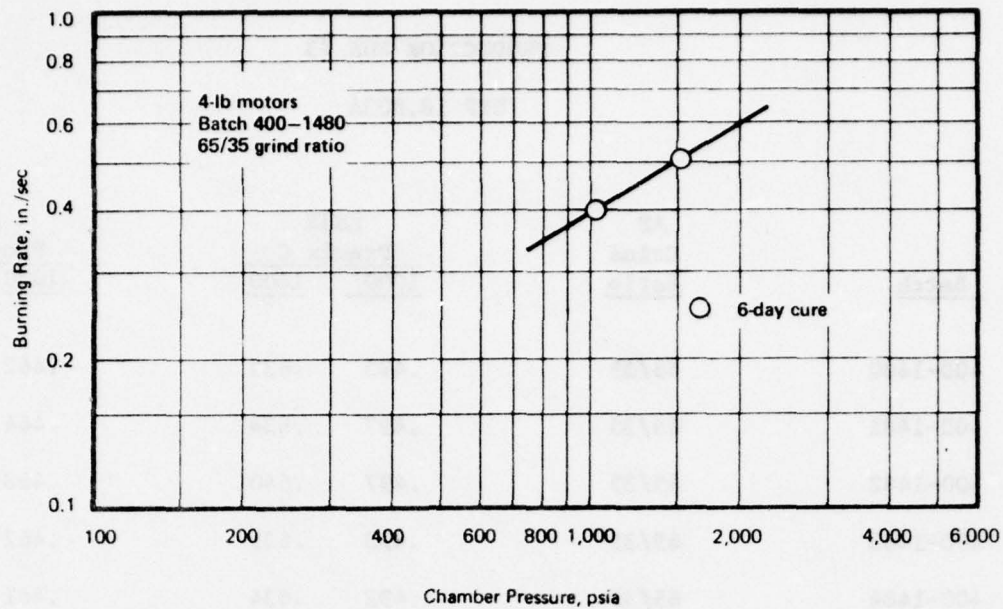
Parameter	1480	1481	1482	1483	1484	1485	400 Gallon Batch				1488	1489	1490	1491	\bar{X}	S_x
Grind ratio	65/35	65/35	65/35	65/35	65/35	66/34	66/34	66/34	66/34	66/34	66/34	66/34	66/34	66/34		
NCO/OH	0.85															
Fuel premix number	3500-3															
IPDI @ 1 hr after addition, wt %	0.38	0.38	0.38	0.36	0.36	0.37	0.37	0.36	0.37	0.37	0.37	0.38	0.37	0.38	0.372	0.0084
Viscosity @ 1 hr after IPDI 2 addition, Kp @ 5000 dynes/cm ²	4.6	4.1	4.9	5.6	5.7	6.5	2.6	6.9	6.1	5.9	7.7	7.1	5.64	1.42		
Max. corrected stress at 75°F, cc/cm, psi	160	149	156	135	147	145	152	144	142	142	151	154	148	6.99		
Max. corrected strain at 75°F, cc/cm, %	31	33	32	31	38	36	37	37	37	31	35	38	34.7	2.87		
True strain @ 75°F rupture, E _r , %	32	34	33	31	39	37	38	38	37	32	36	39	35.5	2.94		
Initial tangent modulus, E _o , psi	844	933	1092	1036	880	1124	1100	1000	918	1104	808	836	973	117		

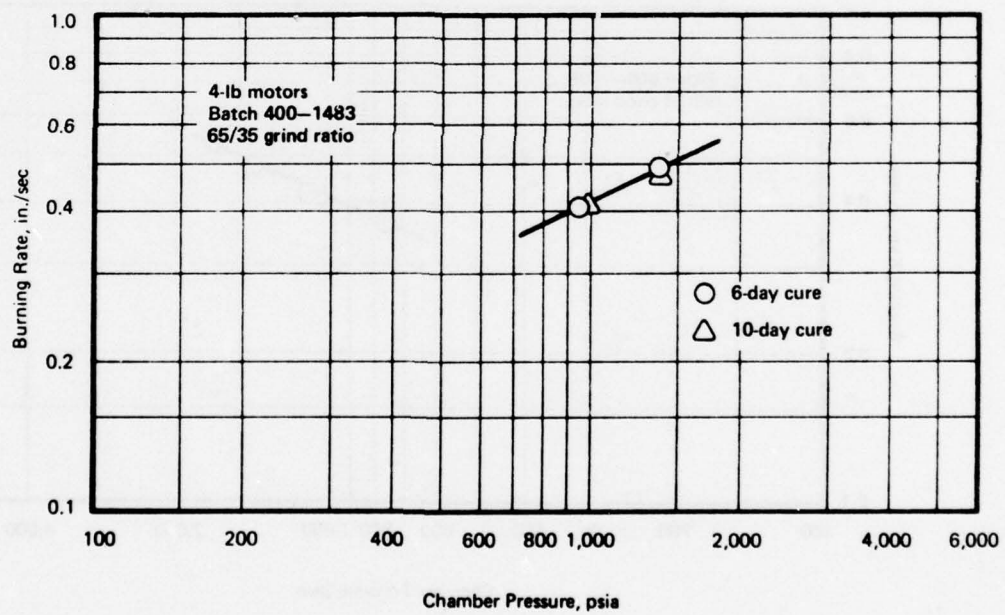
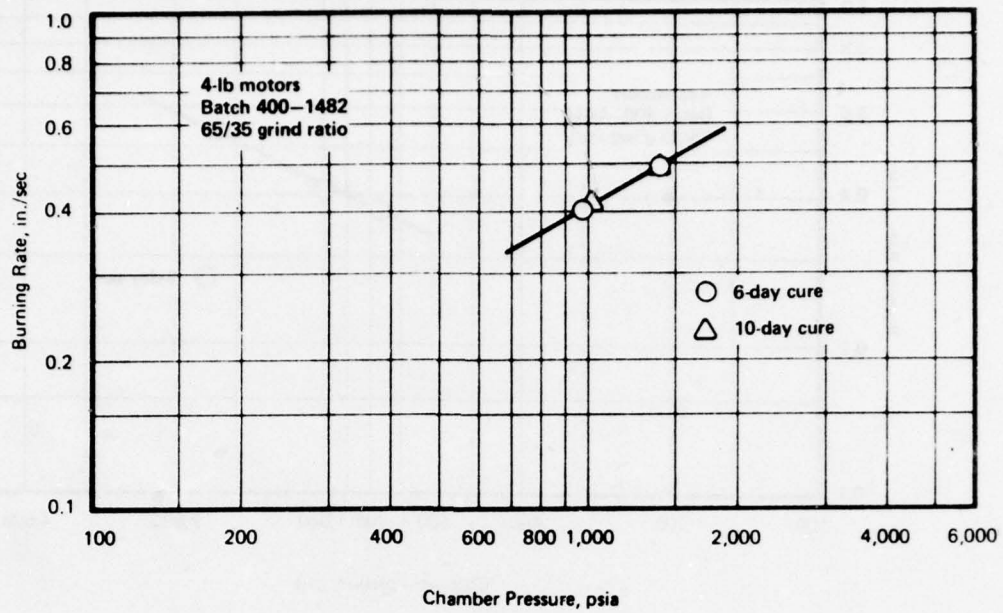
Cartridge lost in 23 May 76 fire

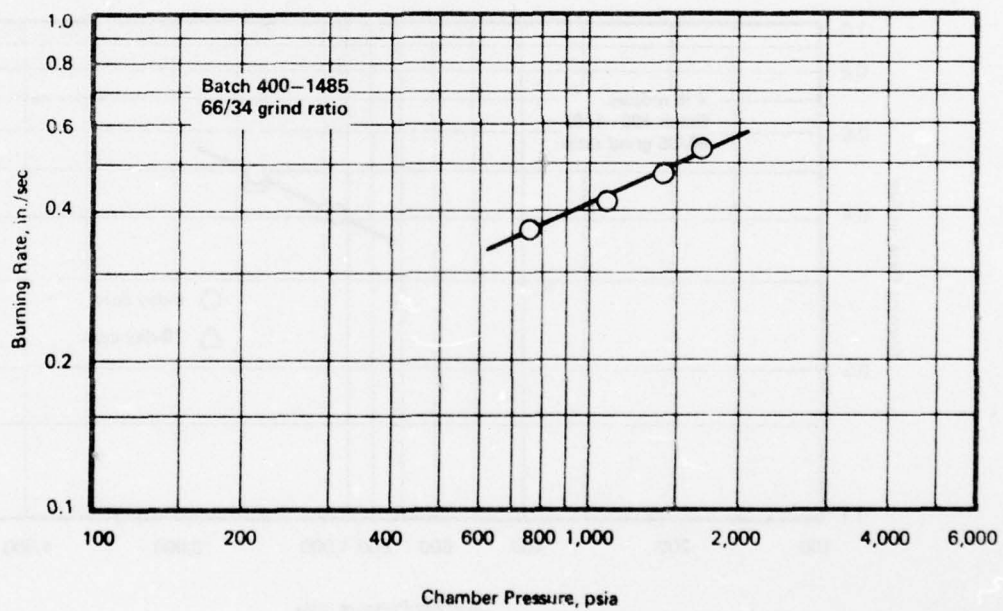
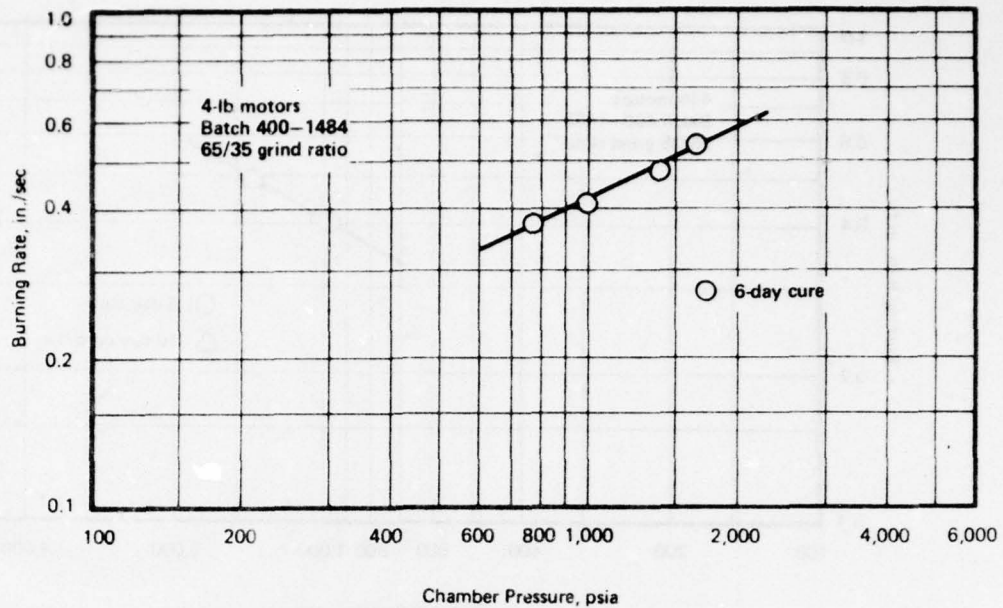
PRODUCTION RUN #3

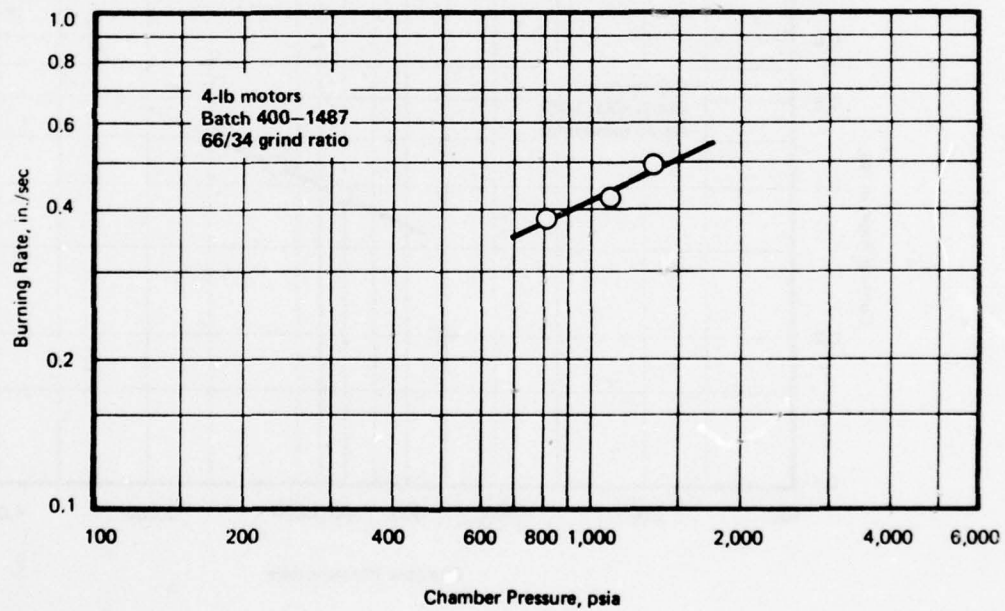
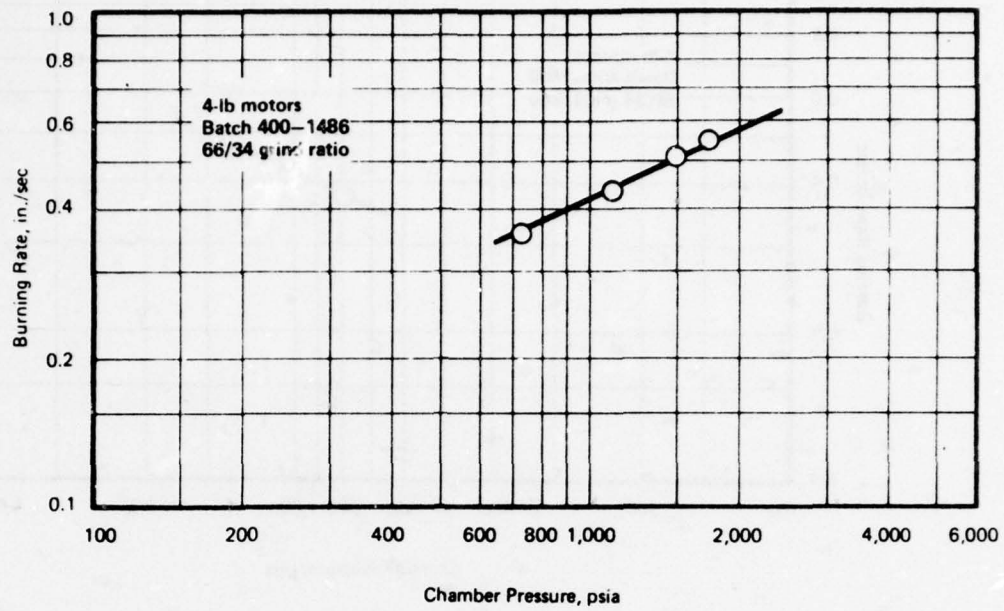
UTP 18,803A

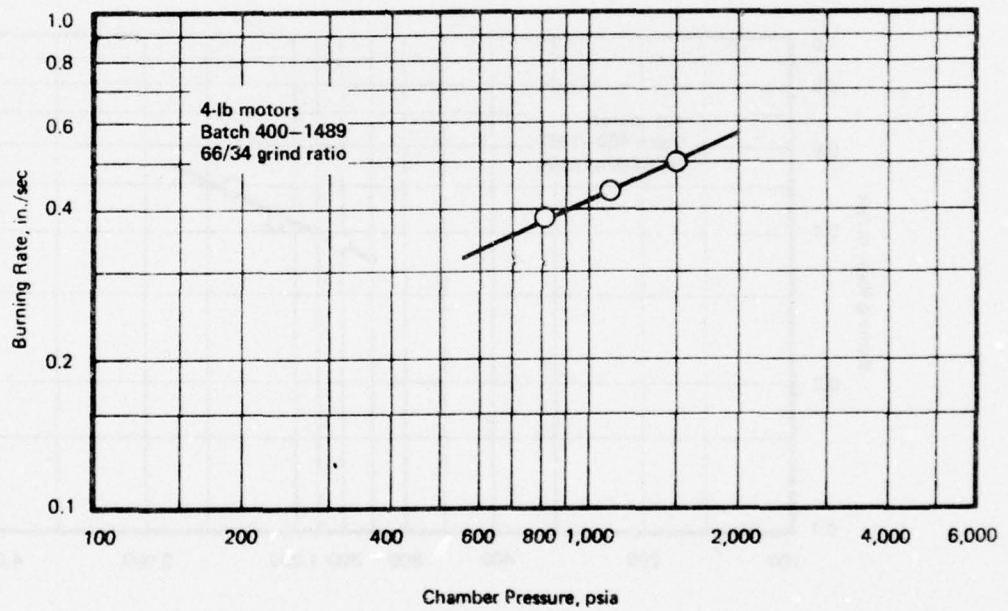
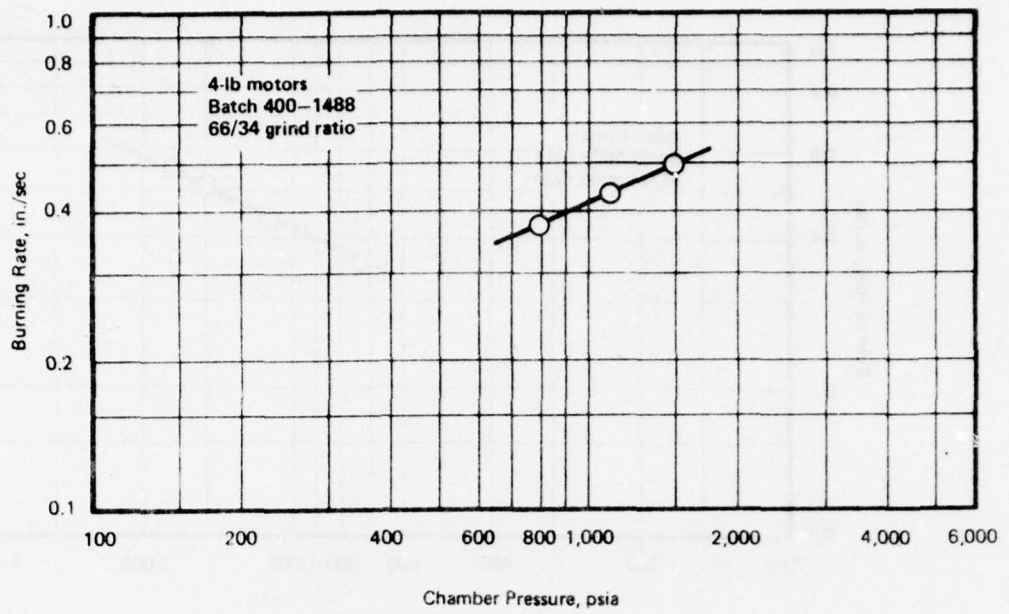
<u>Batch</u>	<u>AP Grind Ratio</u>	<u>LSBR Feed C</u>		<u>LSBR Propellant</u>	
		<u>1000</u>	<u>1400</u>	<u>1000</u>	<u>1400</u>
400-1480	65/35	.493	.632	.462	.588
400-1481	65/35	.497	.634	.464	.588
400-1482	65/35	.497	.640	.468	.592
400-1483	65/35	.493	.635	.462	.587
400-1484	65/35	.492	.634	.461	.588
400-1485	66/34	.485	.623	.463	.589
400-1486	66/34	.487	.621	.461	.581
400-1487	66/34	.487	.623	.463	.581
400-1488	66/34	.491	.627	.464	.587
400-1489	66/34	.494	.629	.461	.579
400-1490	66/34	.491	.625	.462	.580
400-1491	66/34	.488	.632	.462	.589

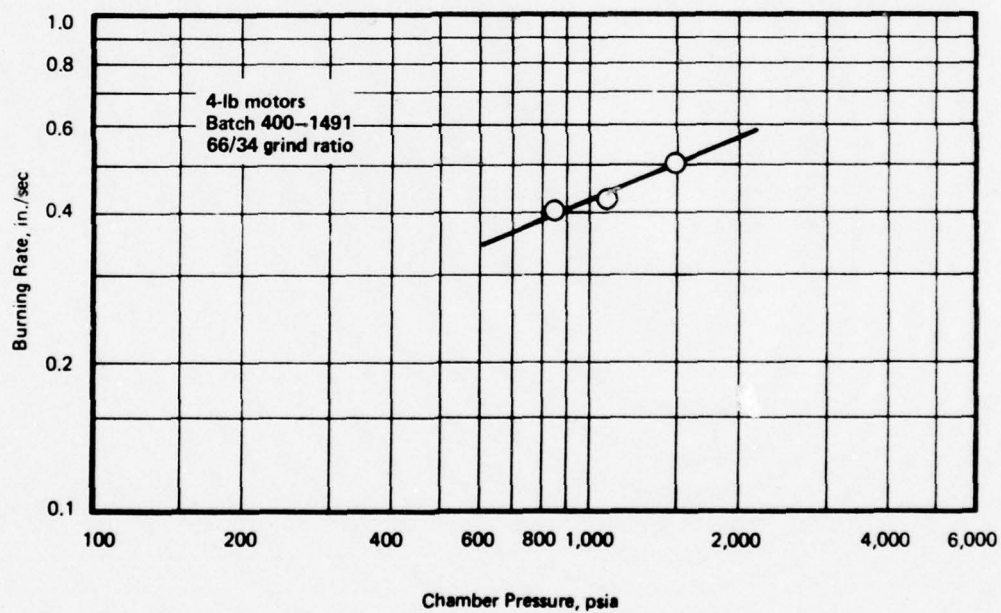
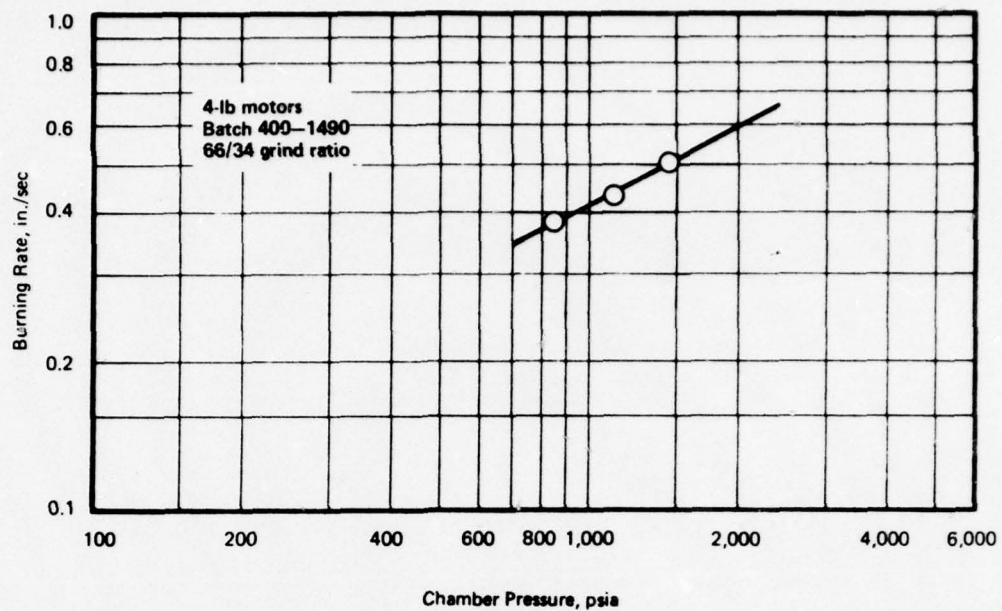












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SECTION 2.6
PRODUCTION RUN NO. 2A
(BATCHES 400-1495 THROUGH 400-1503)

PRODUCTION CASTING #2A

UTP 18803A

BATCHES 400-1495 THROUGH 1503

76°F

Batch	Grind Ratio	All Data	Pressure Exponent	One Standard Deviation, %
		r_{1000} r_{1400} r_{1700}		
400-1495	66/34	0.423 0.507 0.563	0.538	0.4
400-1496	66/34	0.426 0.508 0.563	0.529	1.0
400-1497	66/34	0.419 0.502 0.557	0.540	0.8
400-1498	66/34	0.416 0.499 0.554	0.538	2.1
400-1499	66/34	0.413 0.488 0.537	0.493	1.6
400-1500	66/34	0.416 0.491 0.540	0.492	1.3
400-1501	66/34	0.413 0.482 0.528	0.465	2.1
400-1502	66/34	0.417 0.499 0.553	0.529	1.6
400-1503	66/34	0.418 0.493 0.543	0.490	2.0
Composite of 1495-1503		0.418 0.497 0.550	0.517	2.1

PRODUCTION CASTING #2A

UTP 18803A 66/34 Grind Ratio

BATCHES 400-1495 Thru 1503

76°F

<u>Batch</u>	<u>Chamber Pressure, psia</u>	<u>Burning Rate, in/sec</u>
400-1495	1451	.520
	1830	.5829
	879	.3937
	1263	.4793
400-1496	1490	.5297
	1781	.5761
	905	.4068
	1082	.4378
400-1497	1498	.5251
	1789	.5711
	901.5	.3976
	1122	.4411
400-1498	1470	.5229
	1711	.5507
	861	.3893
	1036	.4140
400-1499	1406	.4872
	1682	.5378
	876	.3933
	1037	.4116
400-1500	1450	.4950
	1760	.5546
	902	.4003
	1070	.4243
400-1501	1434	.4818
	1710	.5378
	849	.390
	1023	.4074
400-1502	1457	.4983
	1782	.576
	869	.3895
	1040	.4270
400-1503	1383	.4839
	1730	.555
	861	.3966
	1024	.4143

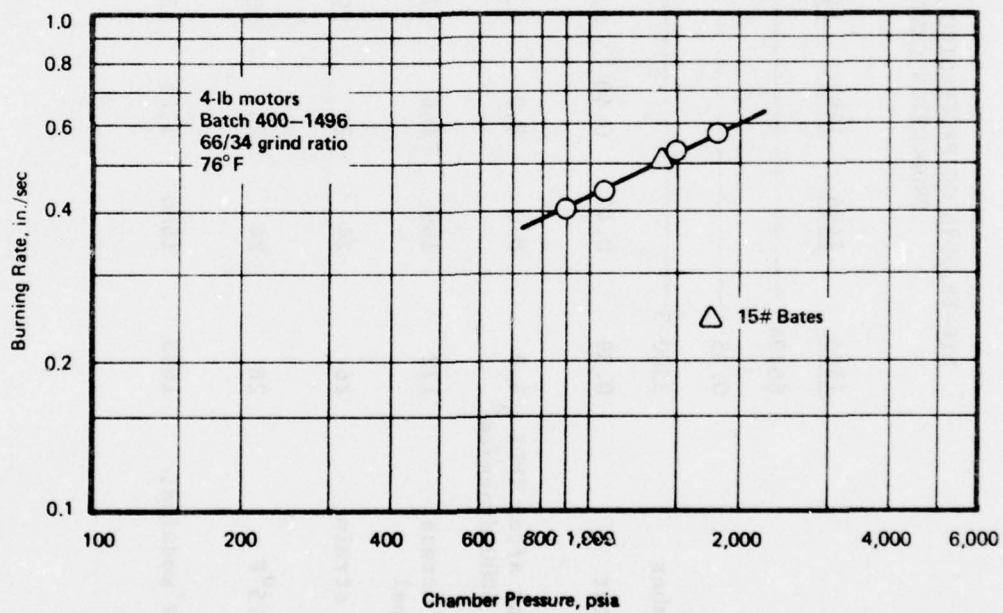
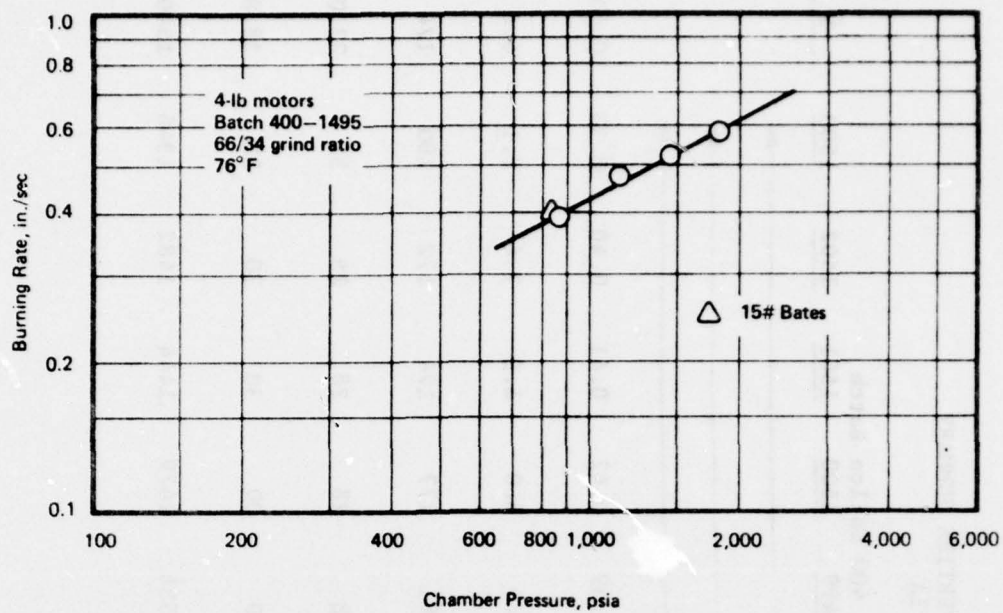
PRODUCTION CASTINGS #2A AND 3A

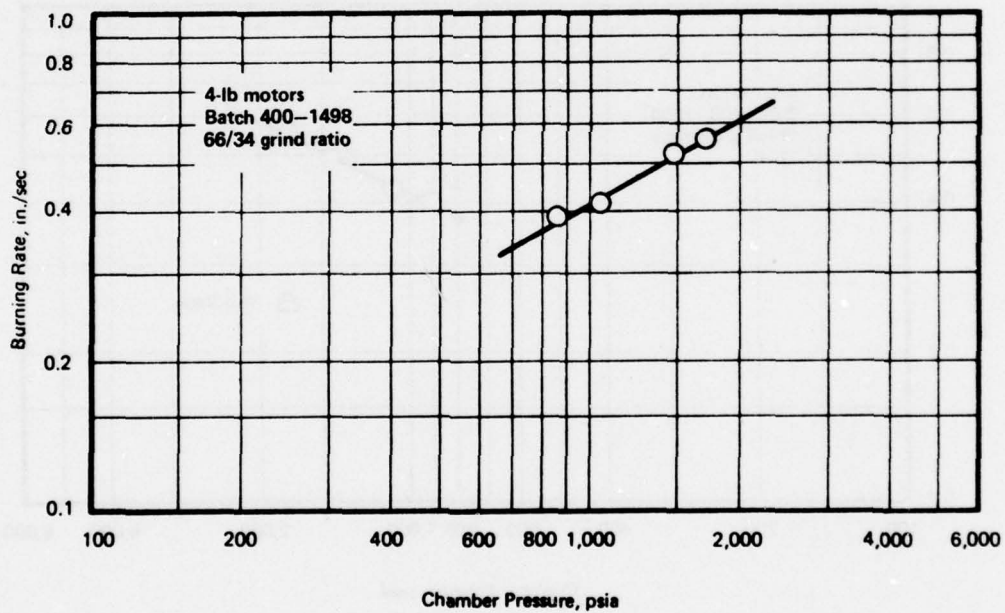
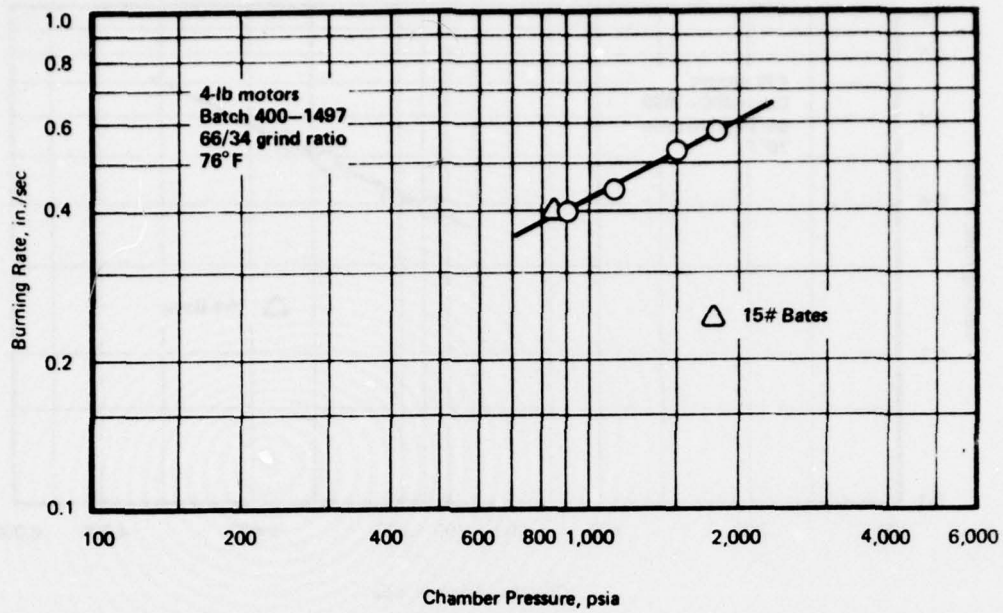
ELSH LSBR Results UTP 18803A

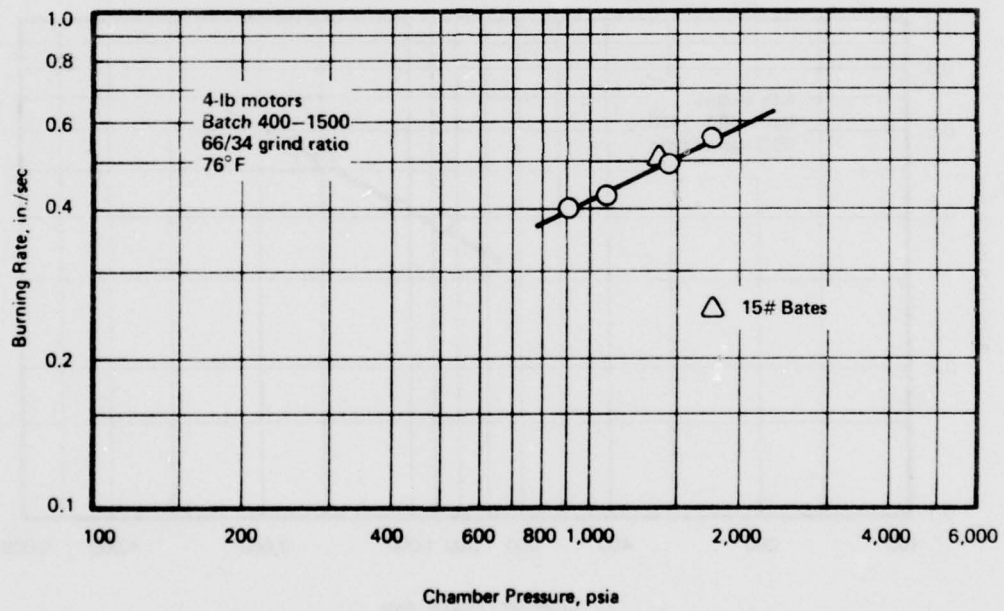
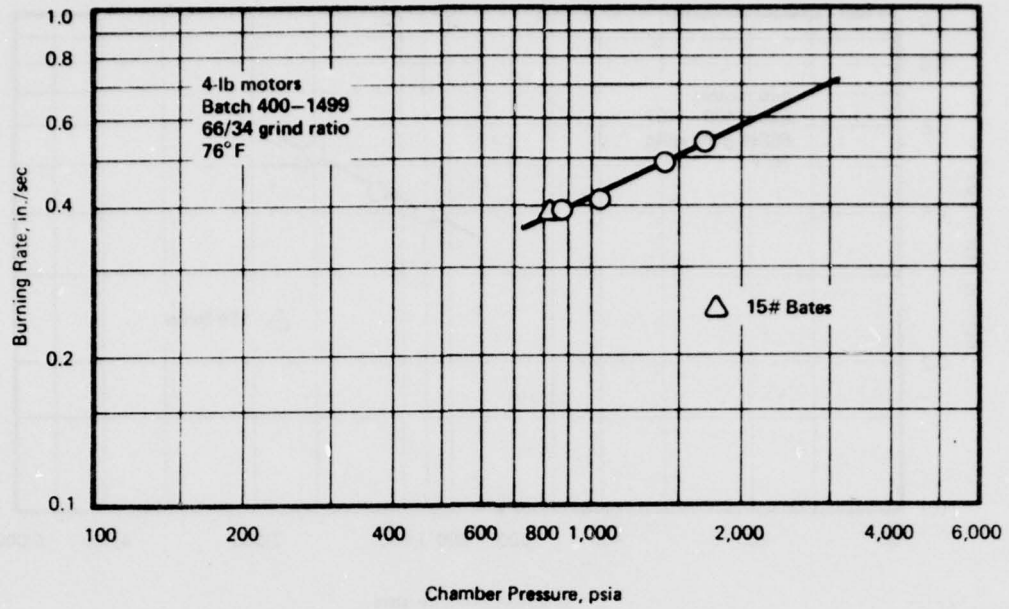
Batch	Premix "C"		Propellant	
	<u>1000 psig</u>	<u>1400 psig</u>	<u>1000 psig</u>	<u>1400 psig</u>
400-1495	0.490	0.632	0.464	0.591
400-1496	0.493	0.639	0.468	0.612
400-1497	0.497	0.644	0.472	0.603
400-1498	0.501	0.642	0.470	0.602
400-1499	0.483	0.623	0.463	0.584
400-1500	0.495	0.634	0.470	0.595
400-1501	0.495	0.632	0.465	0.589
400-1502	0.495	0.638	0.468	0.602
400-1503	0.489	0.639	0.464	0.597
400-1505	0.482	0.620	0.460	0.584
400-1506	0.496	0.634	0.472	0.591
400-1507	0.495	0.634	0.468	0.595
400-1508	0.492	0.650	0.462	0.594
400-1509	0.487	0.632	0.461	0.591
400-1510	0.491	0.635	0.463	0.593
400-1511	0.485	0.618	0.460	0.585
400-1512	0.485	0.628	0.472	0.593
400-1513	0.492	0.632	0.464	0.593
400-1514	0.494	0.632	0.466	0.585
400-1515	0.494	0.643	0.467	0.599
		<u>400-1495</u>	<u>400-1499</u>	<u>400-1503</u>
MSA 10%		3.0	3.7	3.2
50%		9.2	11.0	9.8
90%		24	27	26

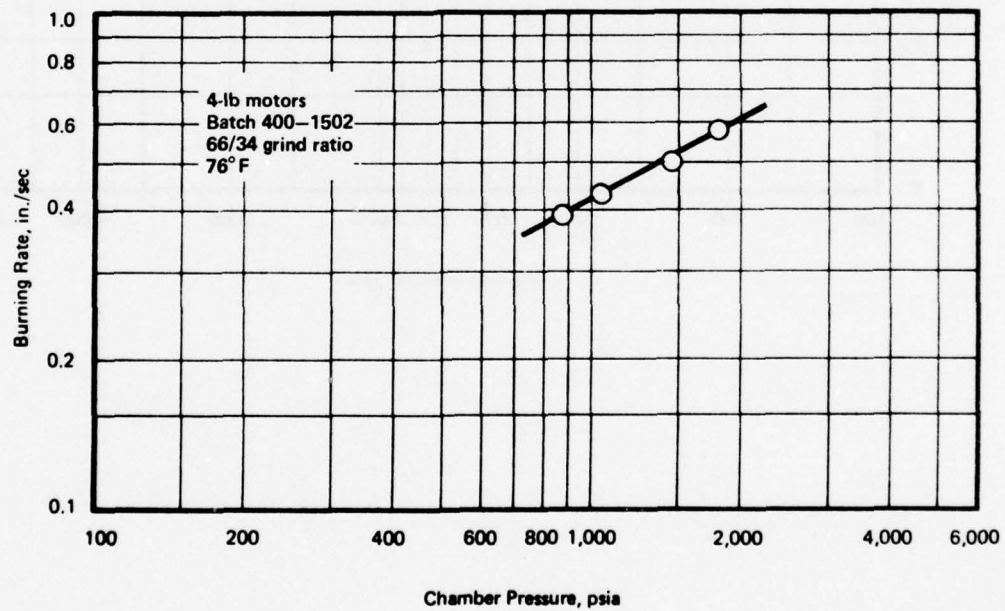
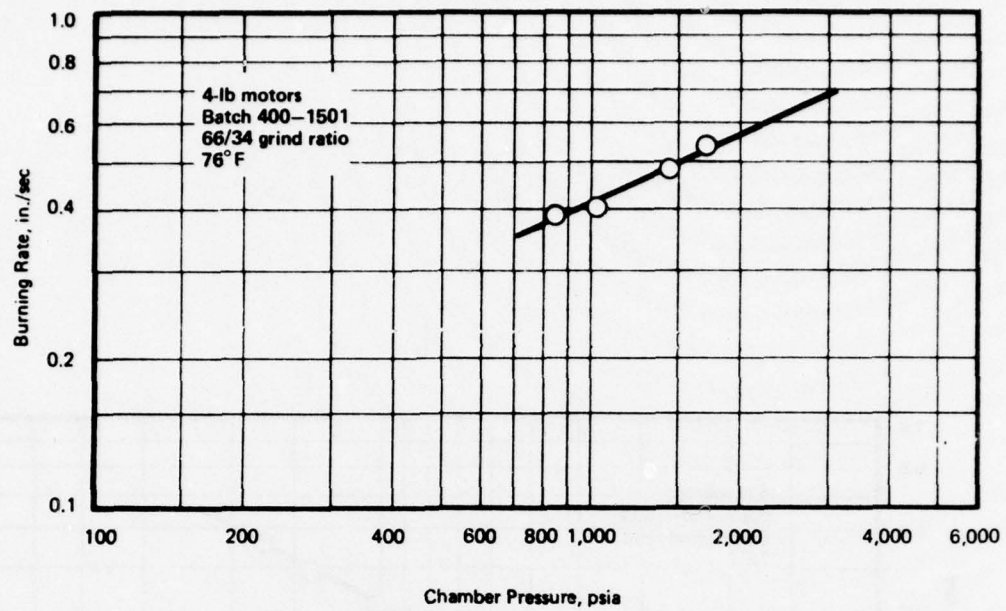
UTP-18,803A QC PROCESSING AND PROPERTIES SUMMARY
PRODUCTION CASTING NO. 2A

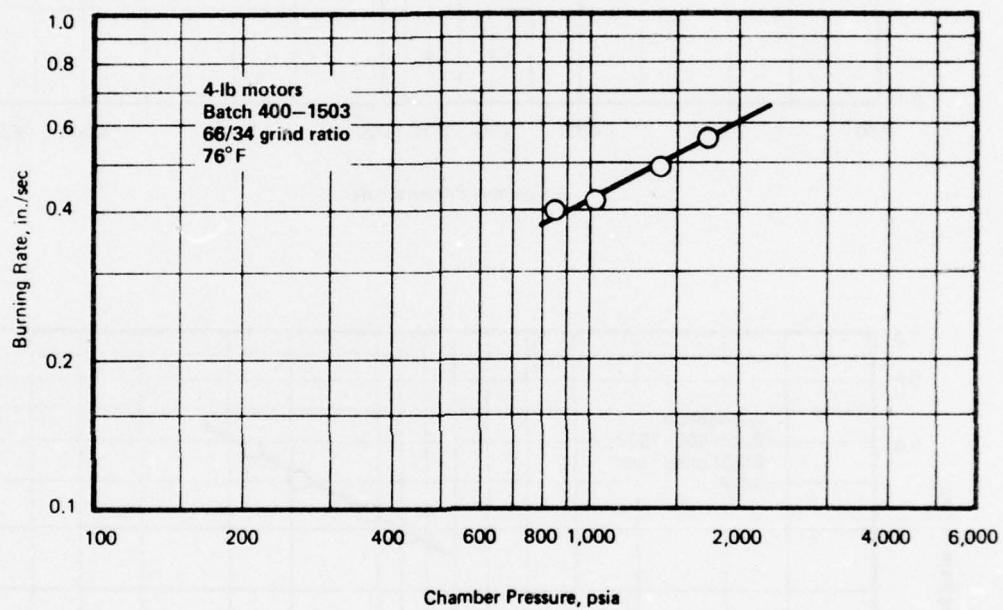
Parameter	1495	1496	1497	1498	1499	1500	400 Gallon Batch			\bar{X}	Sx
							1501	1502	1503		
Grind ratio	66/34										
NCO/OH	0.85										
Fuel premix number	3500-3										
IPDI @ 1 hr after addition, wt %	0.39	0.42	0.40	0.40	0.39	0.42	0.41	0.40	0.30	0.403	0.011
Viscosity @ 1 hr after IPDI ₂ addition, Kp @ 5000 dynes/cm	4.9	8.0	8.0	6.5	5.5	6.0	6.0	7.4	7.1	6.6	1.1
Max. corrected stress at 75°F, σ_{cm} , psi	172	169	166	179	181	177	174	172	183	174	5.17
Max. corrected strain @ 75°F, ϵ_{cm} , %	26	24	24	29	28	28	28	25	31	27.0	2.4
True strain @ 75°F rupture, E_r , %	28	24	24	30	30	30	30	30	33	28.8	2.99
Initial tangent modulus, E_o , psi	1605	1666	1764	1577	1536	1479	1444	1482	1346	1540	125











PRODUCTION RUN NO. 3A
 (BATCHES 400-1505 THROUGH 400-1515)

Batch	Weight	Volume	Temperature	Pressure	Time
400	100.0	100.0	100.0	100.0	100.0
401	100.0	100.0	100.0	100.0	100.0
402	100.0	100.0	100.0	100.0	100.0
403	100.0	100.0	100.0	100.0	100.0
404	100.0	100.0	100.0	100.0	100.0
405	100.0	100.0	100.0	100.0	100.0
406	100.0	100.0	100.0	100.0	100.0
407	100.0	100.0	100.0	100.0	100.0
408	100.0	100.0	100.0	100.0	100.0
409	100.0	100.0	100.0	100.0	100.0
410	100.0	100.0	100.0	100.0	100.0
411	100.0	100.0	100.0	100.0	100.0
412	100.0	100.0	100.0	100.0	100.0
413	100.0	100.0	100.0	100.0	100.0
414	100.0	100.0	100.0	100.0	100.0
415	100.0	100.0	100.0	100.0	100.0
416	100.0	100.0	100.0	100.0	100.0
417	100.0	100.0	100.0	100.0	100.0
418	100.0	100.0	100.0	100.0	100.0
419	100.0	100.0	100.0	100.0	100.0
420	100.0	100.0	100.0	100.0	100.0

PRODUCTION CASTING #3A

UTP 18803A 66/34 GRIND RATIO

4 LB MOTOR 90 F BATCHES 400-1505-1515

400 Gallon Batch	Burning Rate, in/sec			Exponent	σ , %
	@ 1000 psia	@ 1400 psia	@ 1700 psia		
1505	.4036	.4771	.5253	.497	1.4
1506	.4167	.4963	.5490	.520	2.0
1507	.4127	.4903	.5415	.512	1.6
1508	.4173	.4941	.5446	.502	0.6
1509	.4128	.4935	.5470	.531	1.6
1510	.4127	.4920	.5445	.523	0.3
1511	.4121	.4902	.5419	.516	0.8
1512	.4103	.5009	.5621	.594	2.3
1513	.4213	.5017	.5549	.519	2.0
1514	.4194	.5019	.5566	.534	1.7
1515	.4192	.5030	.5589	.542	0.2
Composite	.4142	.4949	.5484	.529	2.0

PRODUCTION CASTING #3A
 UTP 18803A 66/34 GRIND RATIO
 BATCH 400-1505-1515 4 LB MOTOR 90°F

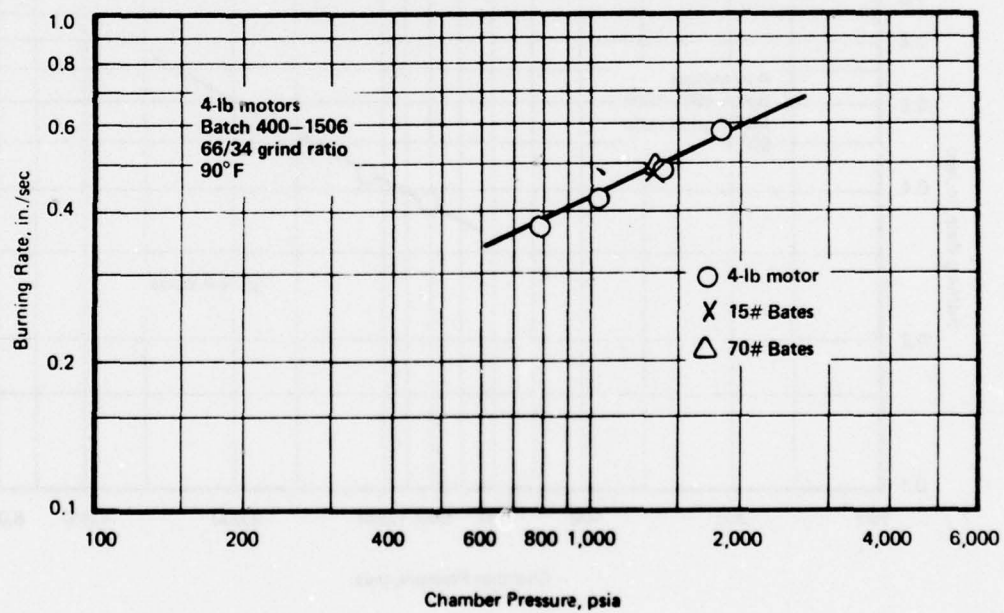
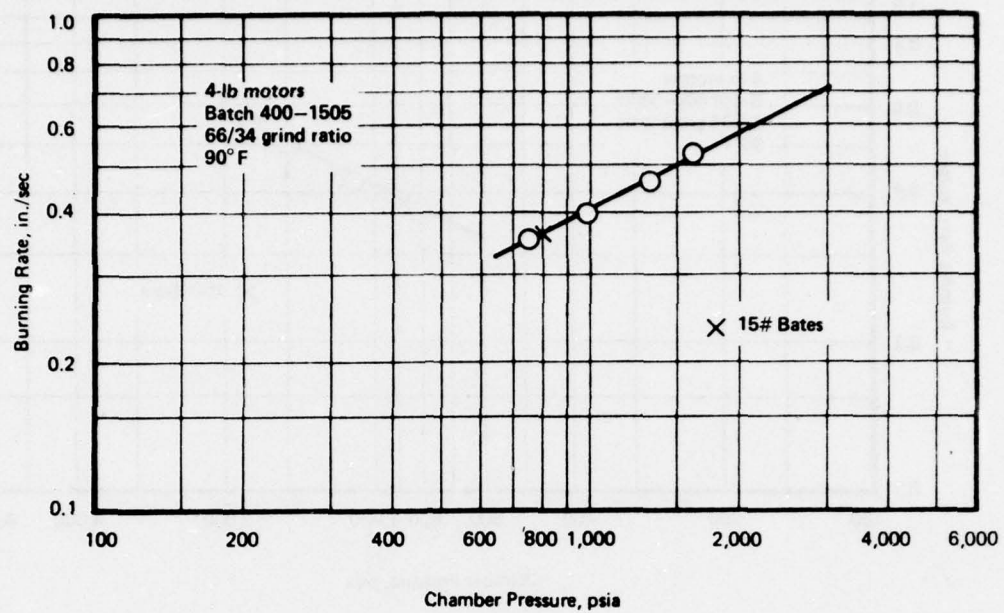
400 Gallon
Batch

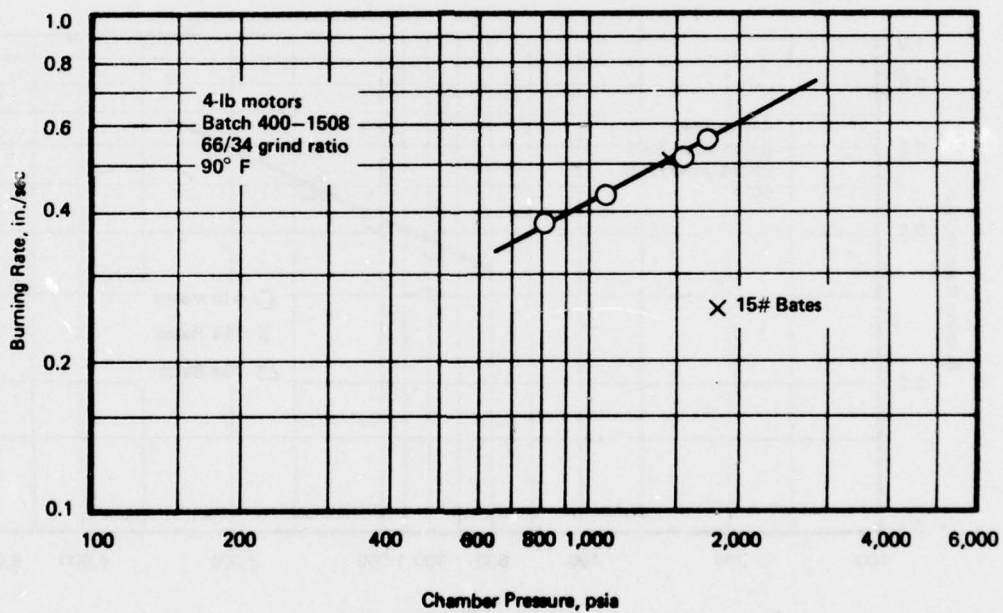
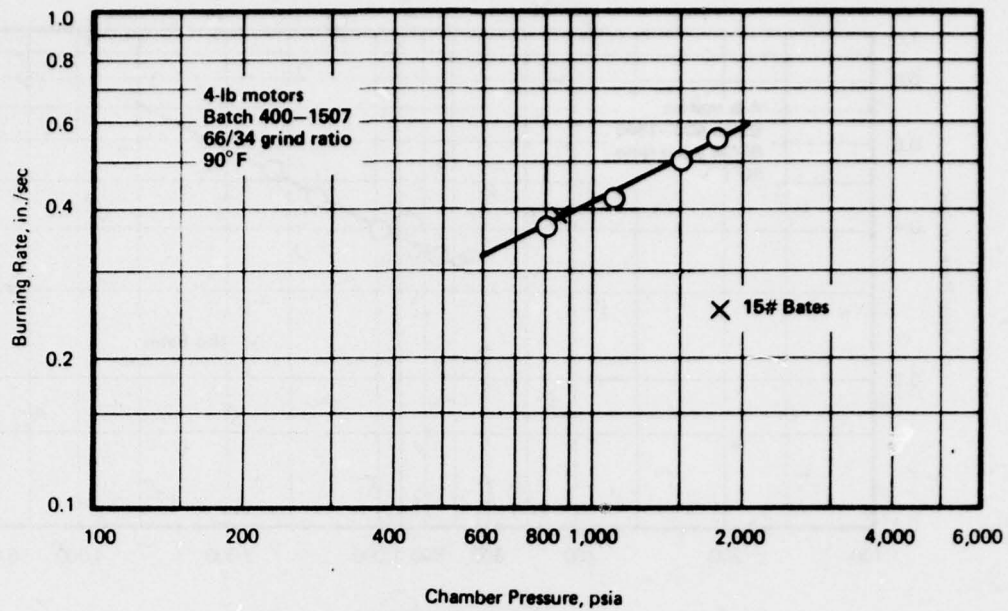
1505	$\frac{r}{P}$, in/sec psia	.3554 760	.3985 990	.4629 1361	.5223 1630
1506	$\frac{r}{P}$, in/sec psia	.3769 801	.4209 1042	.4864 1404	.5812 1831
1507	$\frac{r}{P}$, in/sec psia	.3731 800	.4238 1097	.5033 1487	.5558 1747
1508	$\frac{r}{P}$, in/sec psia	.3806 826	.4324 1084	.5159 1544	.5538 1734
1509	$\frac{r}{P}$, in/sec psia	.3727 813	.4214 1054	.5075 1528	.5605 1720
1510	$\frac{r}{P}$, in/sec psia	.3718 823	.4318 1083	.5201 1552	.5457 1716
1511	$\frac{r}{P}$, in/sec psia	.3717 808	.4260 1088	.5064 1494	.555 1764
1512	$\frac{r}{P}$, in/sec psia	.3786 842	.415 1064	.5060 1458	.597 1826
1513	$\frac{r}{P}$, in/sec psia	.3798 795	.4259 1065	.5173 1520	.5687 1721
1514	$\frac{r}{P}$, in/sec psia	.3915 854	.4261 1071	.5248 1543	.5727 1752
1515	$\frac{r}{P}$, in/sec psia	.3758 816	.4404 1097	.5201 1496	.5781 1802

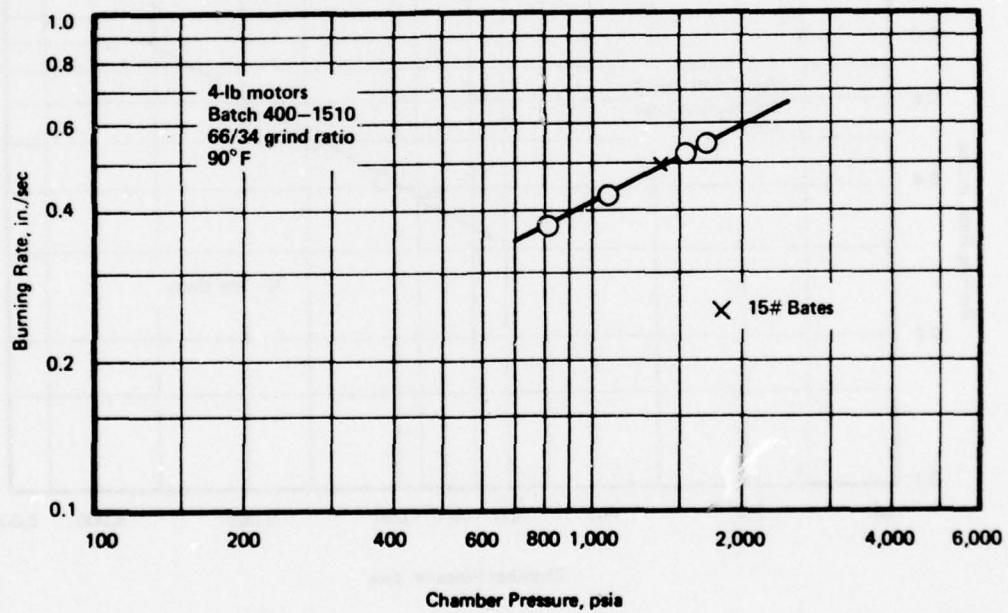
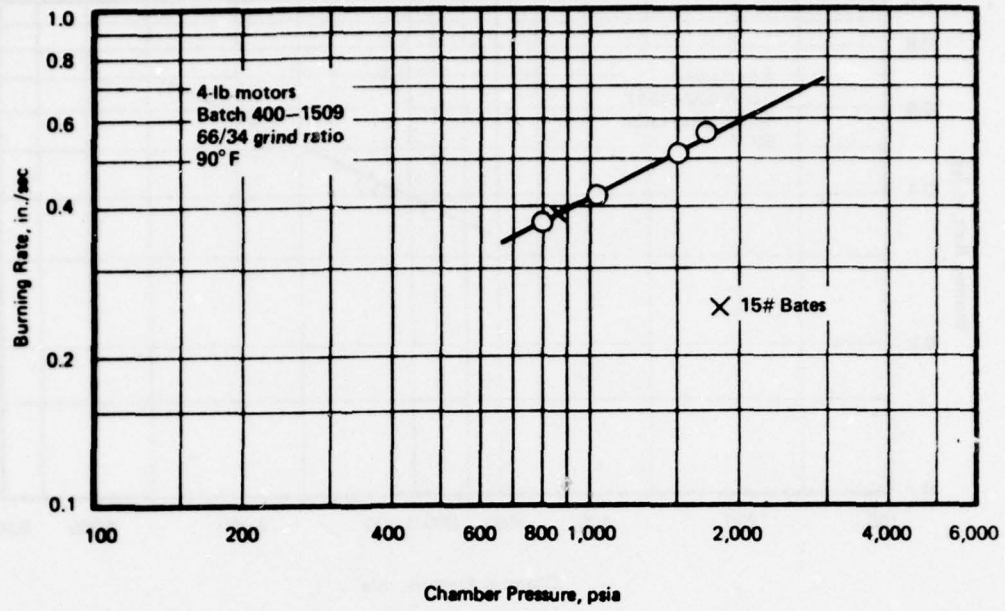
UTP-18,803A QC PROCESSING AND PROPERTIES SUMMARY
PRODUCTION CASTING NO. 3A

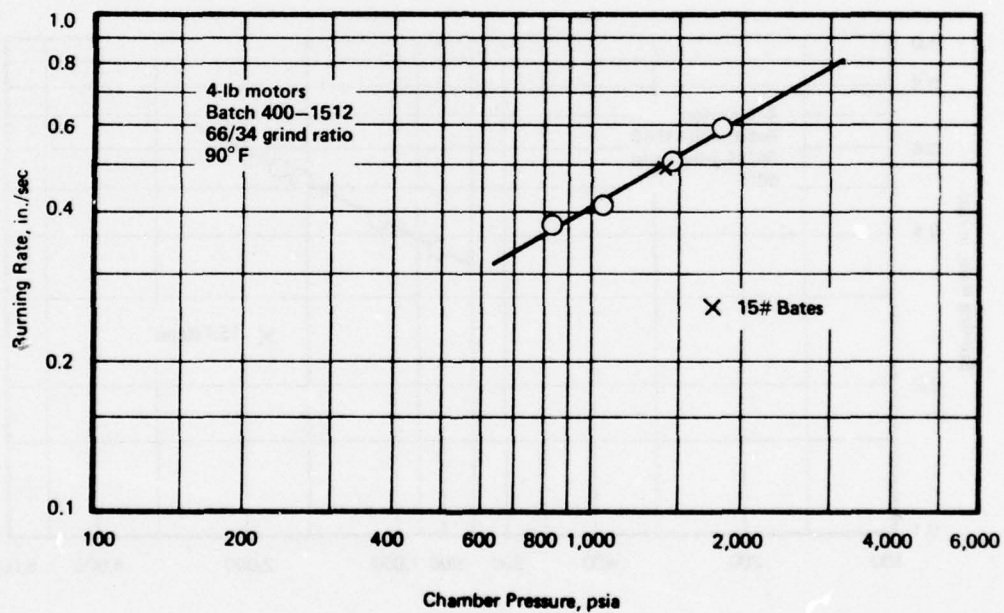
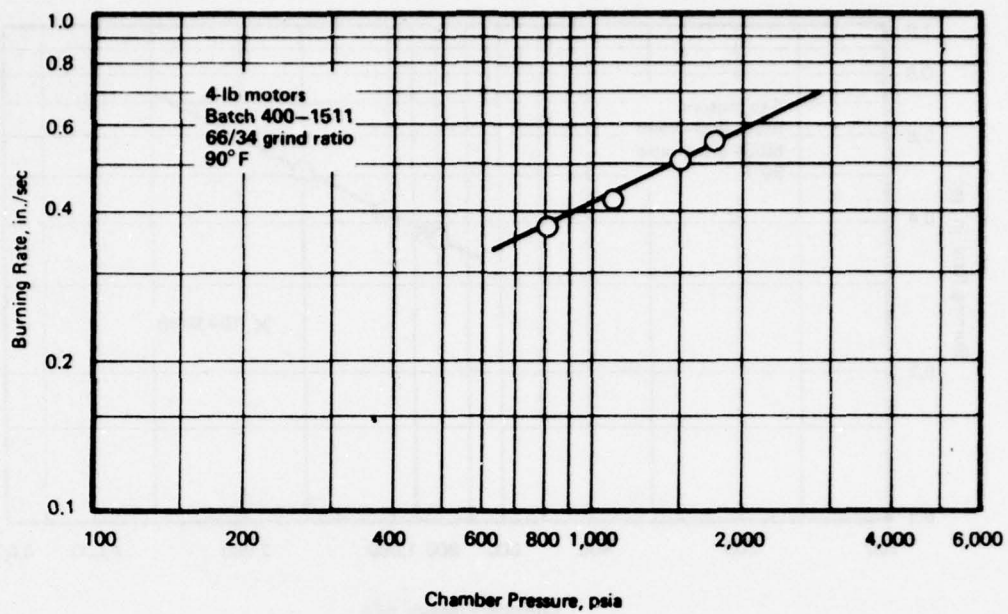
Parameter	1505	1506	1507	1508	1509	400 Gallon Batch				1515	\bar{x}	S_x
						1510	1511	1512				
Grind ratio	66/34											
NCO/OH	0.82											
Fuel premix number	3500-4											
IPDI @ 1 hr after addition, wt %	0.40	0.39	0.40	0.38	0.38	0.38	0.39	0.40	0.40	0.38	0.389	0.0094
Viscosity @ 1 hr after IPDI 2 addition, Kp @ 5000 dynes/cm ²	3.8	5.7	8.5	5.5	4.8	4.5	6.4	8.3	5.3	5.3	5.84	1.46
Max. corrected stress @ 75°F, σ_m , psi	98	129	126	121	127	124	120	132	126	128	124	9.34*
Max. corrected strain @ 75°F, ϵ_m , %	36	31	31	27	35	35	32	34	35	36	32.9	2.91
True strain @ 75°F rupture, ϵ_r , %	38	32	32	30	36	36	33	34	36	37	34.0	2.79
Initial tangent modulus, E_0 , psi	534	930	744	1057	894	822	669	717	670	732	778	144

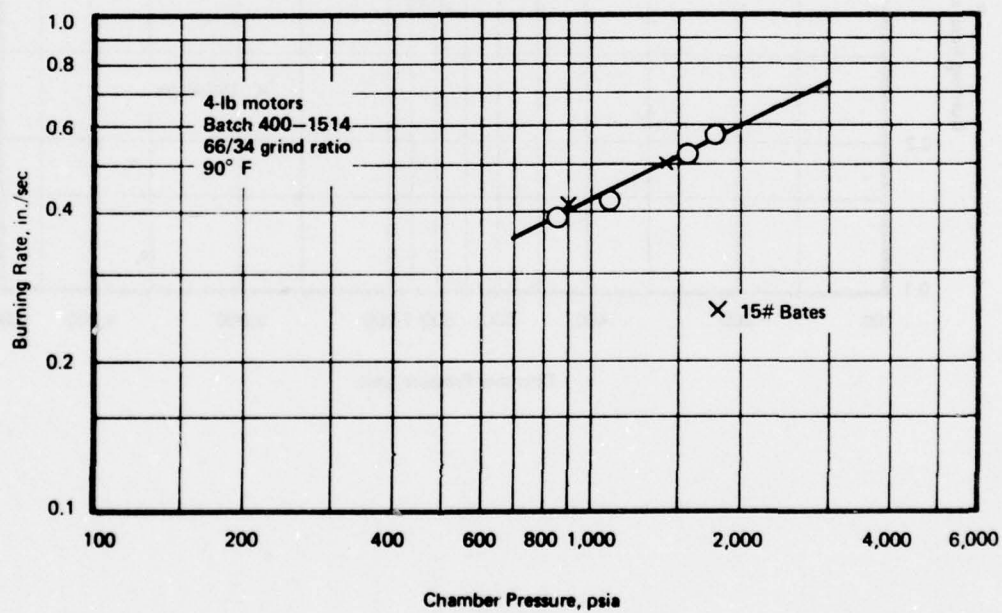
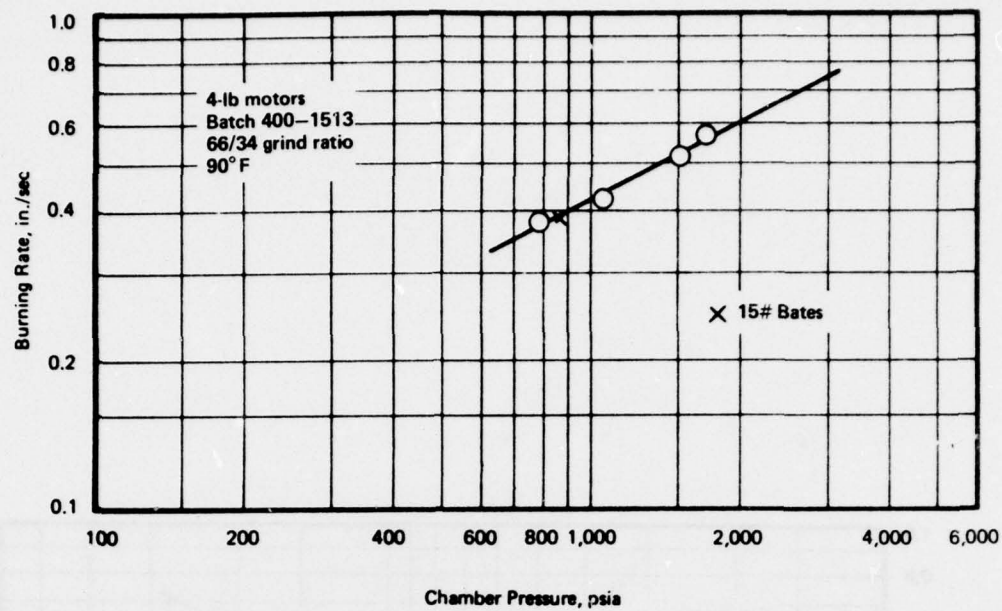
* \bar{x} = 126 and S_x = 3.92 if eliminate 400-1505

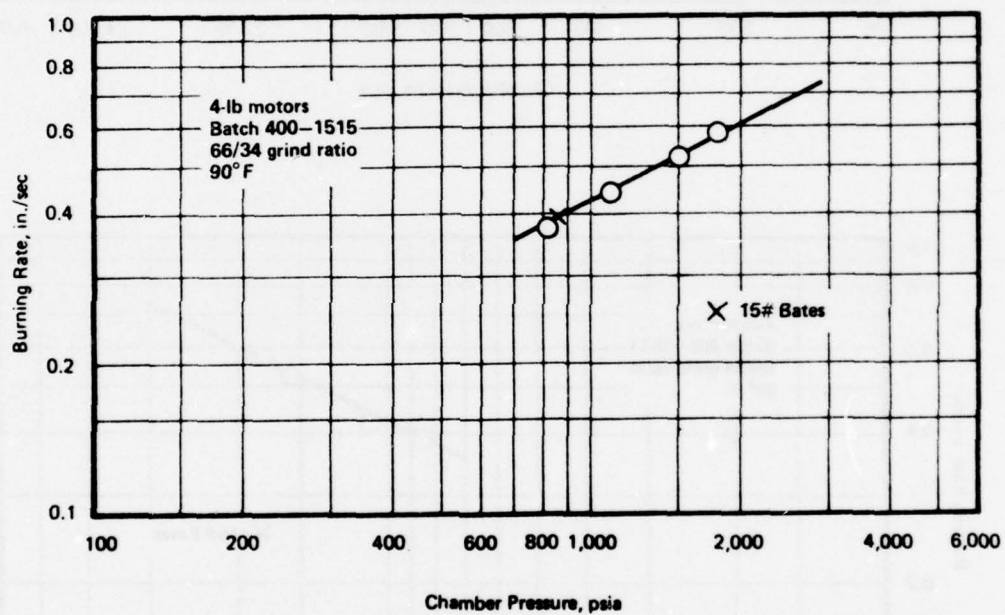


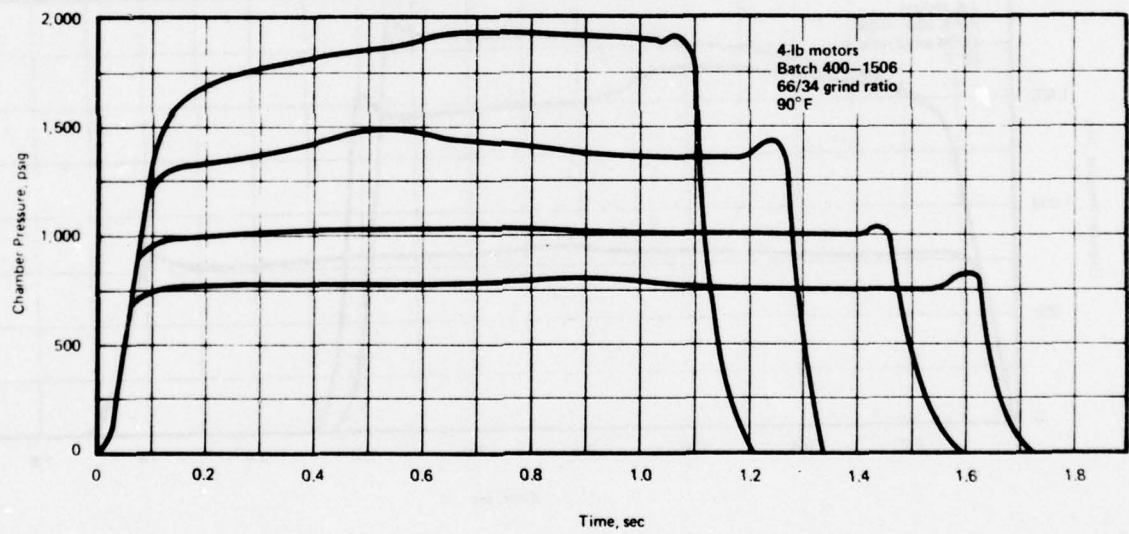
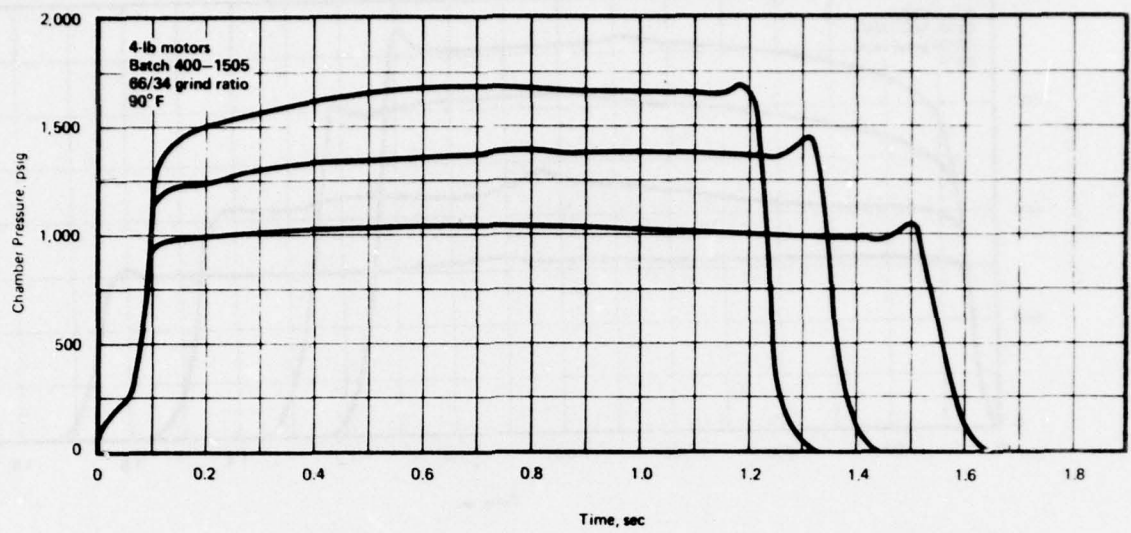


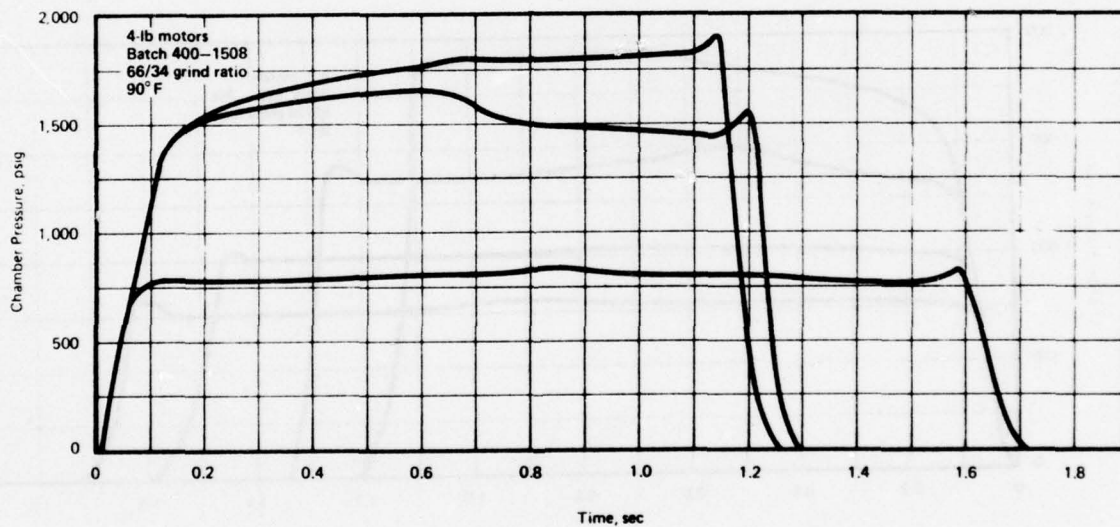
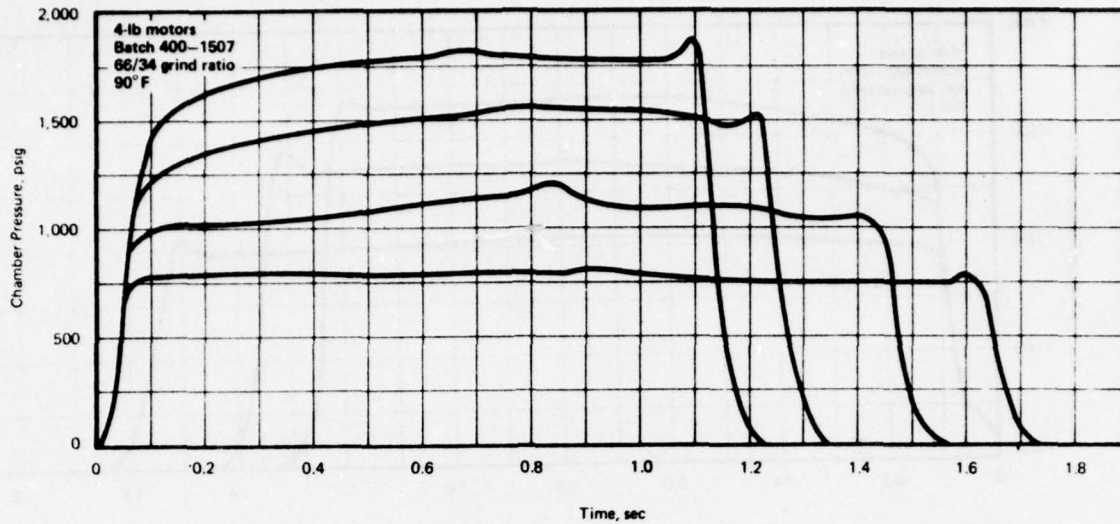












81

PRODUCTION CASTING #4
 UTP 18803A 68/32 GRIND RATIO
4-LB MOTOR, 90°F, BATCHES 400-1516-1524

400-Gallon Batch	Burning Rate, in/sec			Exponent	$\sigma, \%$
	1000 psia	1400 psia	1700 psia		
400-1516	.4014	.4665	.5088	.446	1.2
400-1517	.4046	.4728	.5173	.463	.51
400-1518	.4001	.4762	.5266	.517	.80
400-1519	.4006	.4710	.5171	.481	.28
400-1520	.4061	.4711	.5133	.441	1.1
400-1521	.4034	.4766	.5248	.496	1.2
400-1522	.4022	.4688	.5122	.456	.96
400-1523	.4020	.4720	.5178	.477	.82
400-1524	.4014	.4728	.5197	.487	1.7
400-1525	.3989	.4693	.5154	.483	.29
Composite	.4021	.4715	.5168	.473	1.30
1516-1525					

90°F UTP 18803A 66/34 GRIND RATIO

400-1526	.4123	.4879	.5377	.500	1.52
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PRODUCTION CASTING #4
18803 68/32 GRIND RATIO
BATCH 400-1516-1524, 4-LB MOTOR, 90°F

<u>400-Gallon Batch</u>	<u>\dot{r}, in/sec</u>	<u>P, psia</u>
1516	.3652	792
	.3964	1,001
	.4624	1,409
	.4914	1,521
1517	.3675	802
	.4060	1,030
	.4666	1,357
	.4882	1,490
1518	.3663	834
	.3914	978
	.4625	1,297
	.4780	1,425
1519	.3651	820
	.4026	1,019
	.4719	1,410
	.4898	1,510
1520	.3649	769
	.4010	996
	.4598	1,360
	.4995	1,551
1521	.3683	820
	.4000	1,016
	.4786	1,366
	.4983	1,555
1522	.3558	755
	.3997	984
	.4436	1,293
	.5159	1,680
1523	.3657	802
	.3964	1,005
	.4848	1,467
	.5100	1,642
1524	.3599	767
	.3881	985
	.4550	1,316
	.5178	1,638

<u>400-Gallon Batch</u>	<u>r, in/sec</u>	<u>P, psia</u>
1525	.5100	1,650
	.4772	1,460
	.4039	1,031
	.3558	786

66/34 Grind Ratio

1526	.558	1,778
	.489	1,449
	.411	1,016
	.3699	787

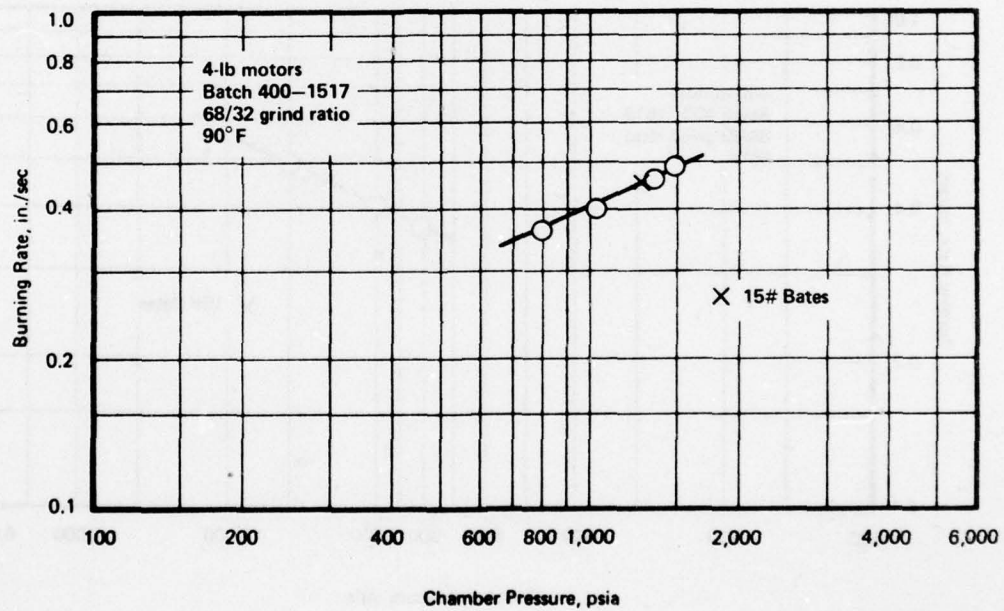
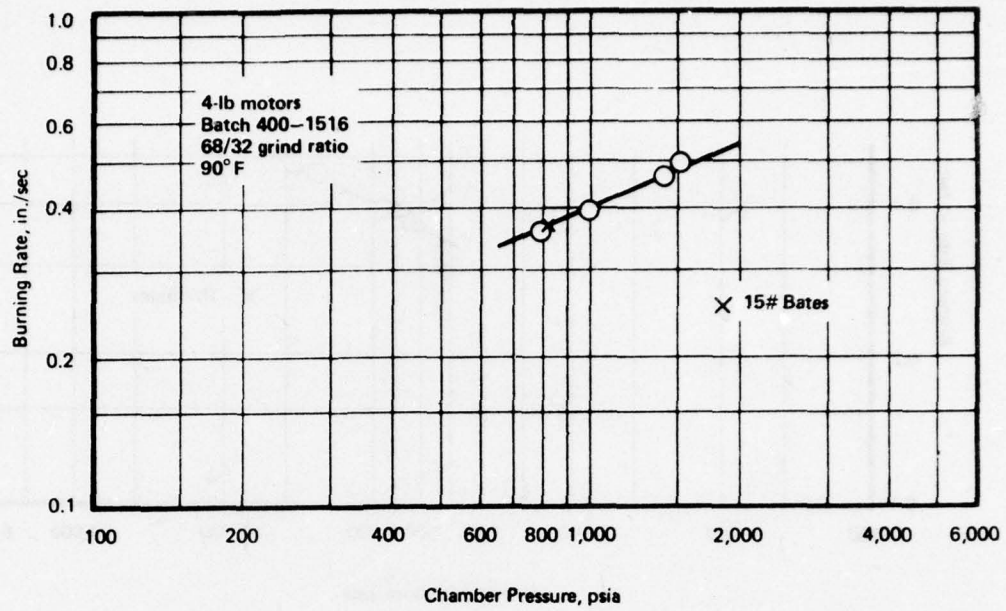
PRODUCTION CASTING #4

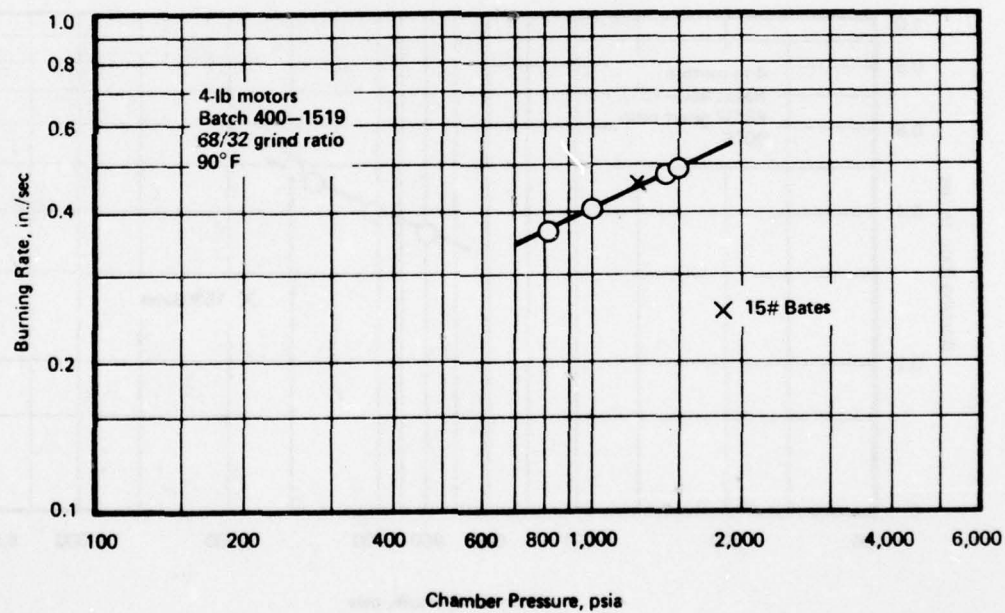
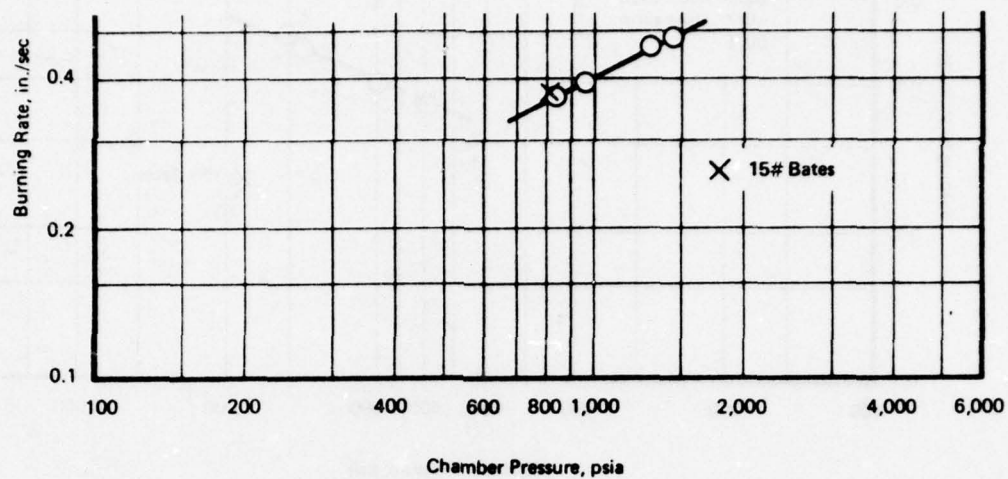
LSBR - UTP, 18,803A

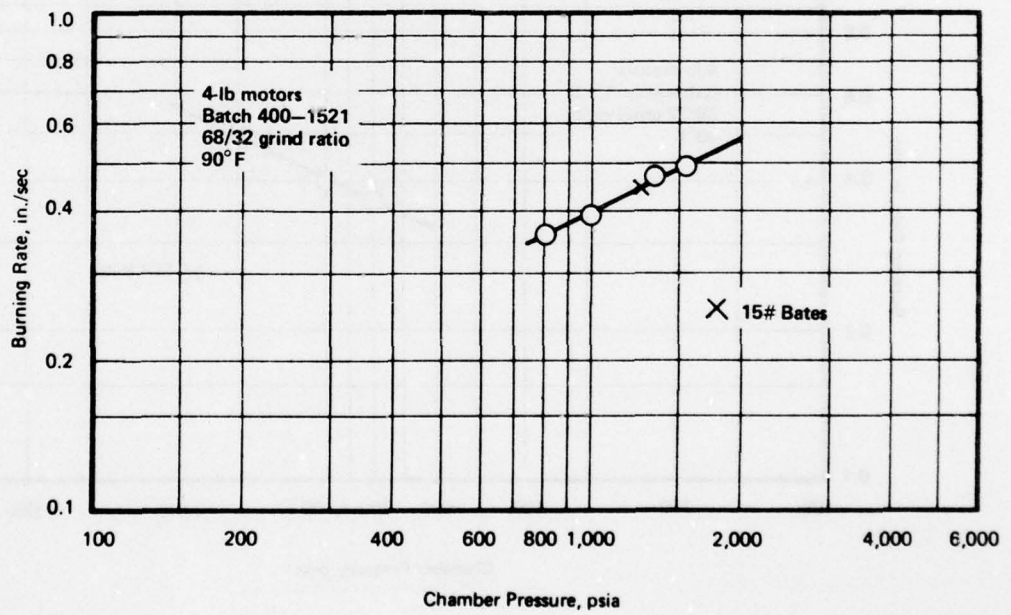
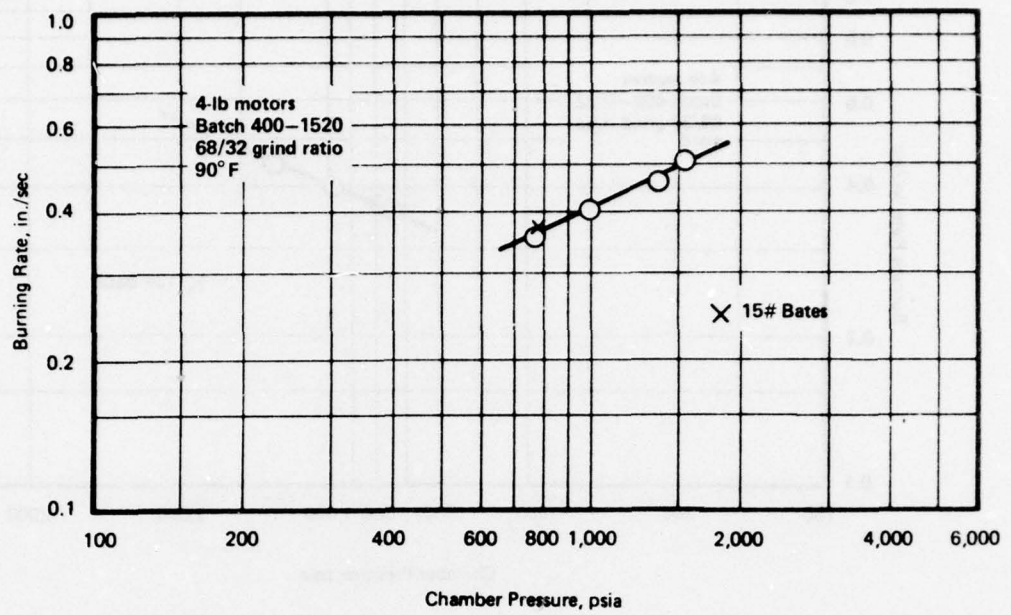
<u>Batch</u>	<u>Pressure</u>	<u>Premix C</u>	<u>Propellant</u>	<u>Ratio</u>	<u>Curative Ratio</u>
400-1516	1000	.480	.453	68/32	0.82
	1400	.621	.572		
400-1517	1000	.481	.454	68/32	0.82
	1400	.613	.575		
400-1518	1000	.482	.456	68/32	0.82
	1400	.613	.578		
400-1519	1000	.481	.448	68/32	0.82
	1400	.605	.564 & .560		
400-1520	1000	.475	.447	68/32	0.82
	1400	.603	.565		
400-1521	1000	.472	.445	68/32	0.82
	1400	.603	.562		
400-1522	1000	.464	.442	68/32	0.82
	1400	.598	.557		
400-1523	1000	.473	.448	68/32	0.82
	1400	.600	.562		
400-1524	1000	.473	.444	68/32	0.82
	1400	.598	.560		
400-1525	1000	.472	.446	68/32	0.82
	1400	.601	.565		
400-1526	1000	.487	.444 & .443	66/34	0.82
	1400	.627	.561 & .555		

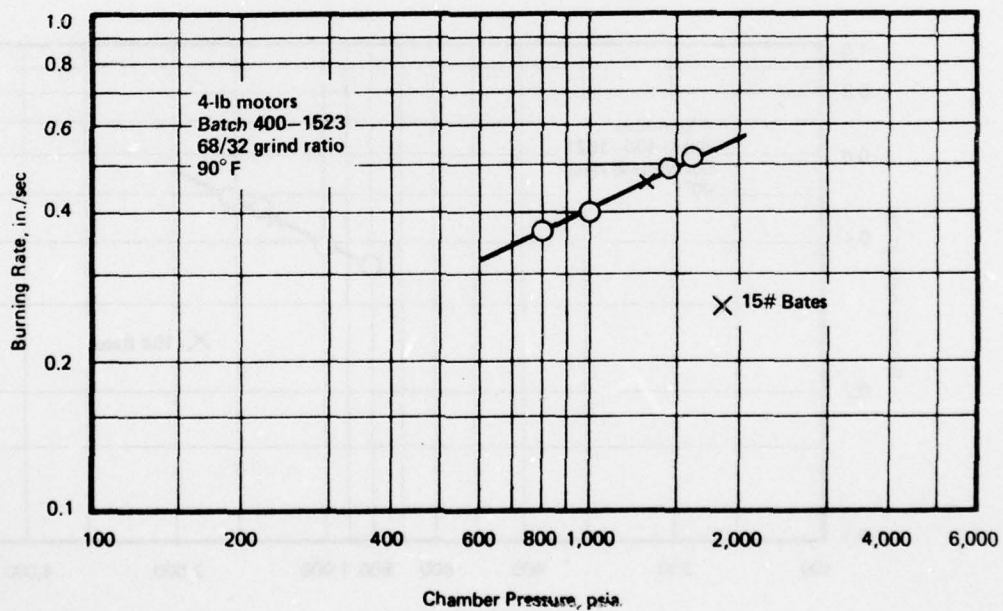
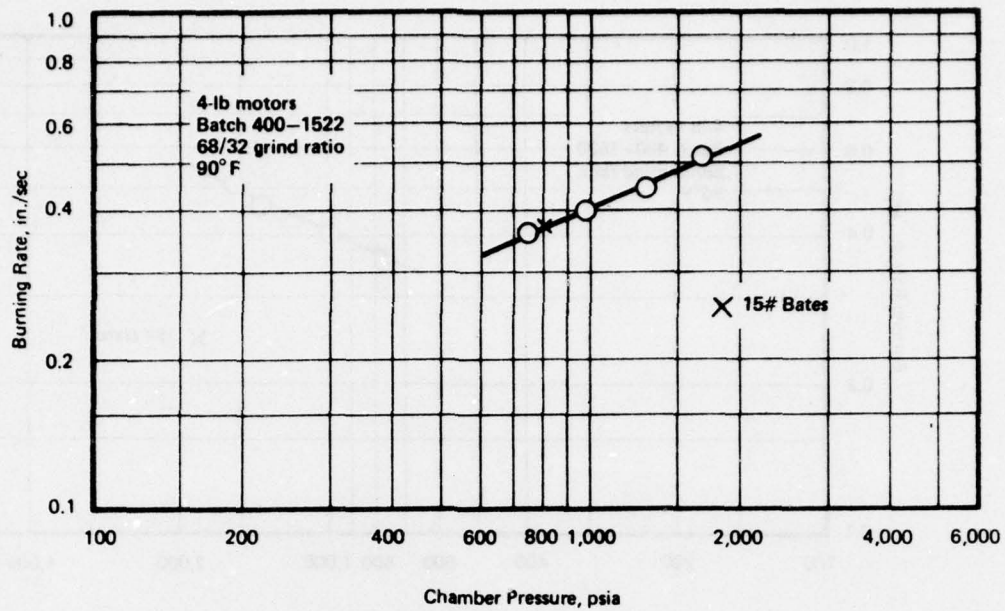
UTP-18,803A QC PROCESSING AND PROPERTIES SUMMARY
PRODUCTION CASTING NO. 4

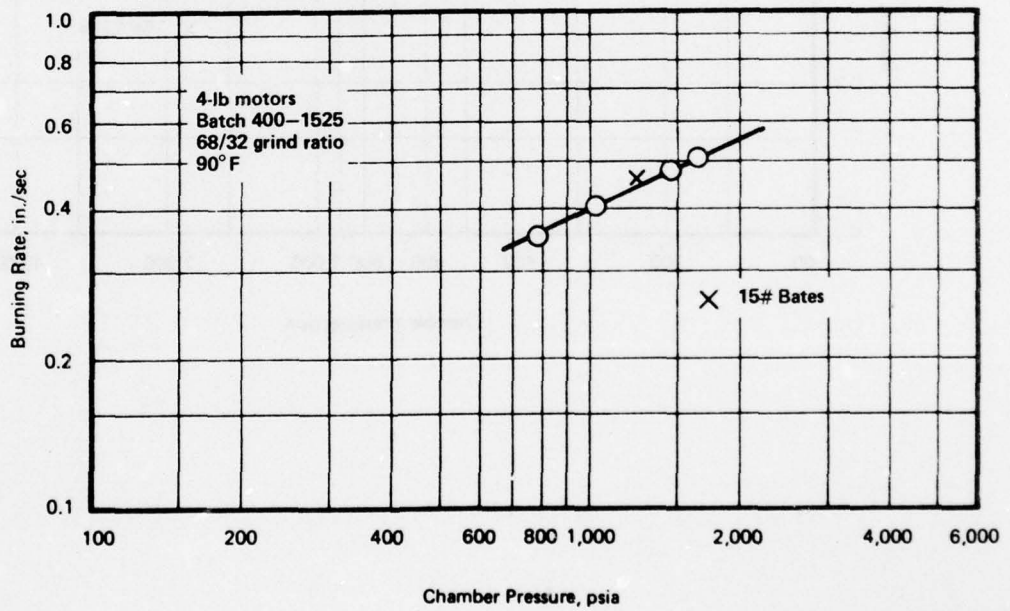
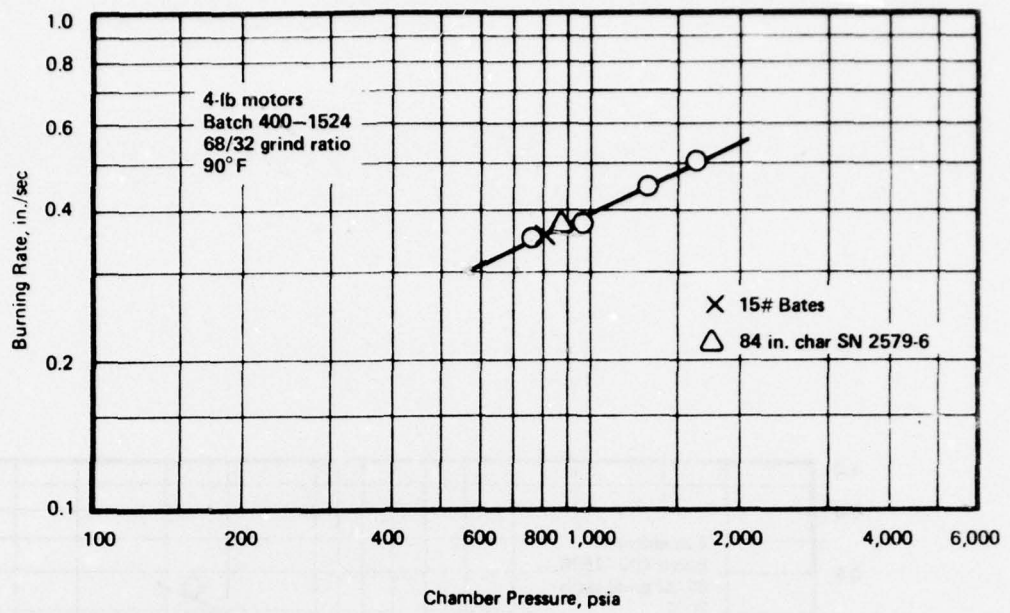
Parameter	1516	1517	1518	1519	1520	400 Gallon Batches					\bar{X}	Sx
						1521	1522	1523	1524	1525		
Grind ratio	68/32										1526	
NCO/OH	0.82										66/34	
Fuel premix number	3500-5											
IPDI @ 1 hr after addition, wt %	0.37	0.38	0.37	0.35	0.37	0.34	0.37	0.38	0.37	0.37	0.28	0.0029
Viscosity @ 1 hr after IPDI ² addition, Kp @ 5000 dynes/cm ²	5.3	4.65	4.28	3.43	4.14	4.40	5.57	4.55	4.45	4.42	4.93	0.0058
Max corrected stress @ 75°F, σ_{cm} , psi	112	116	120	114	115	110	113	114	113	115	114	2.52
Max corrected strain @ 75°F, ϵ_{cm} , %	34	31	40	36	42	34	38	33	36	40	40	3.52
True strain @ 75°F rupture, ϵ_r , %	35	32	41	38	43	36	39	34	37	41	42	3.55
Initial tangent Modulus, E_o , psi	561	649	651	488	468	536	508	653	594	636	568	69.5

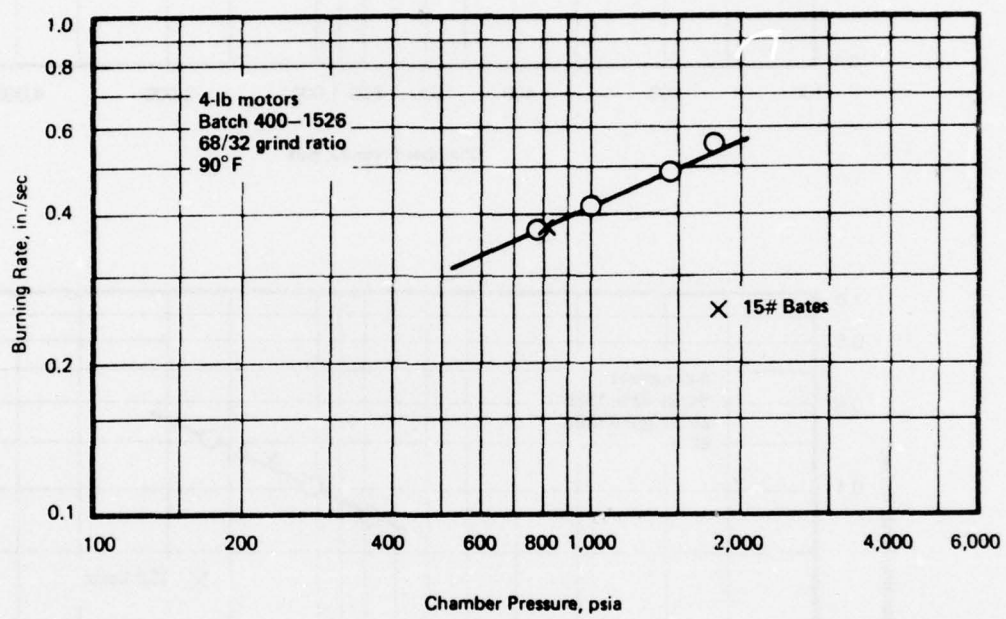


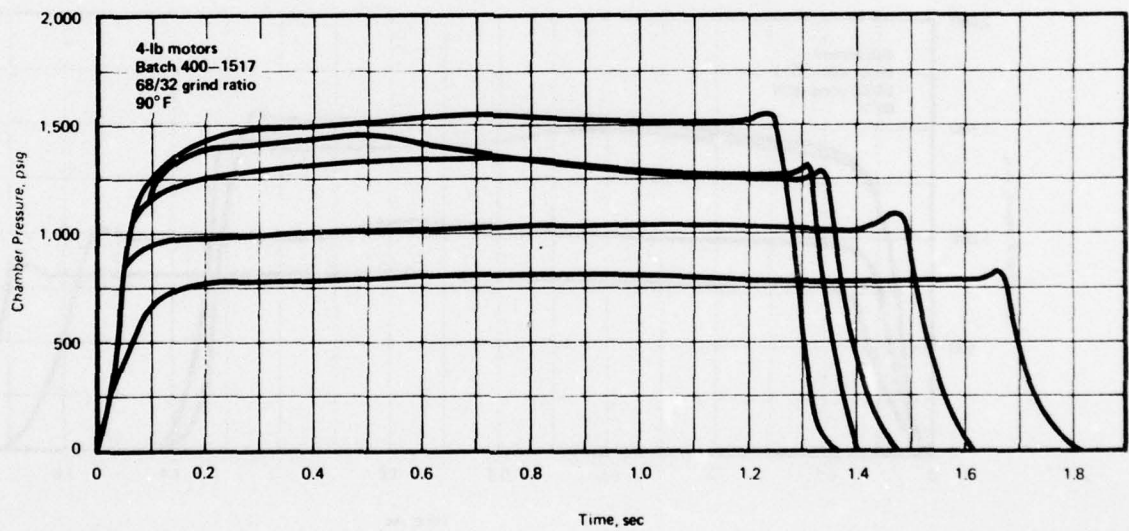
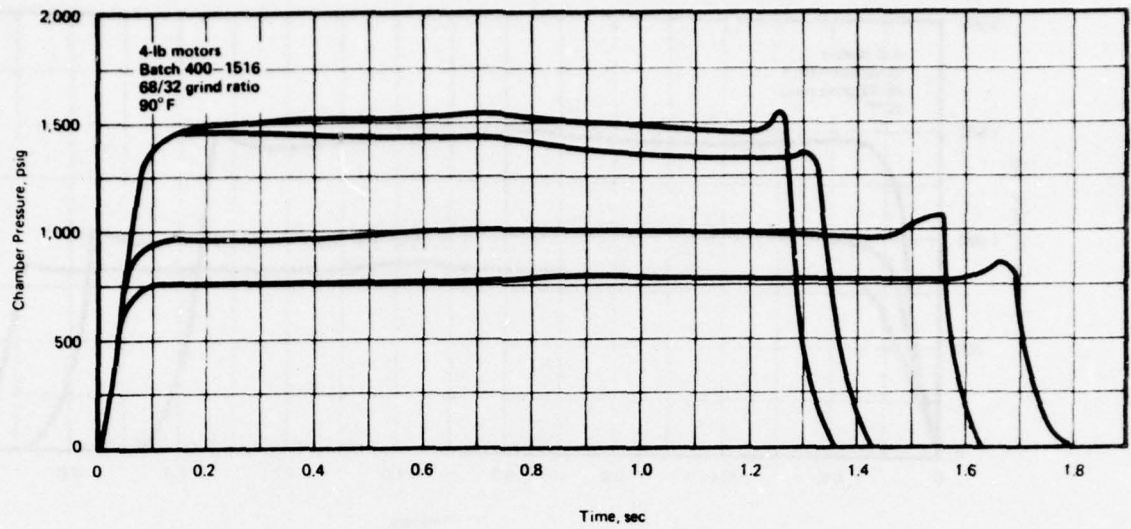


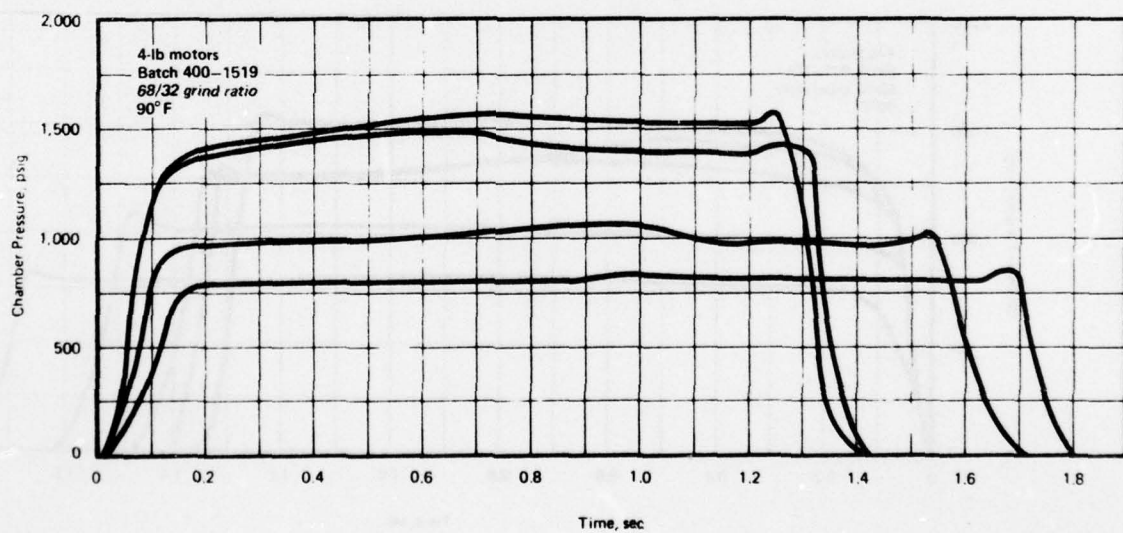
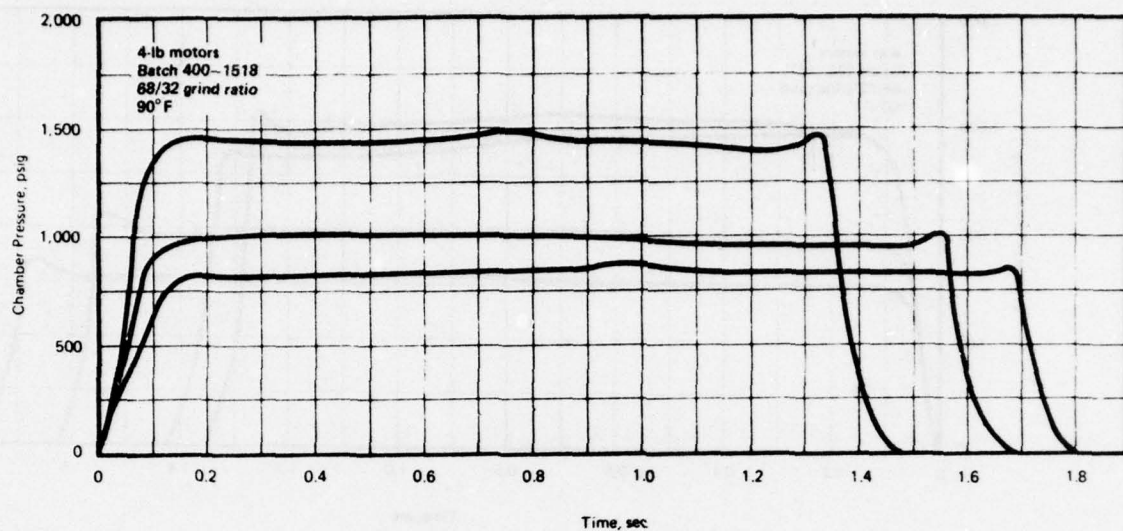


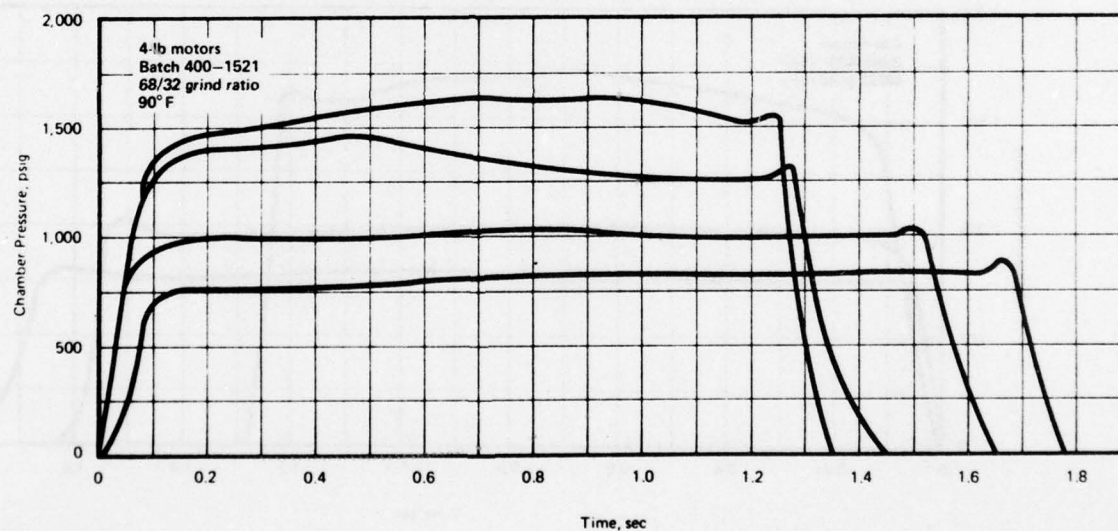
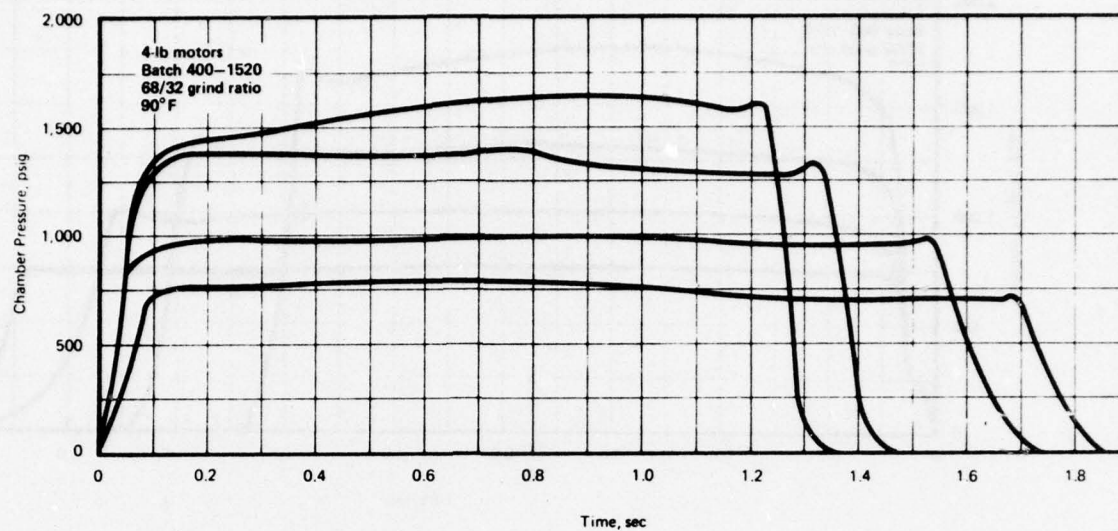


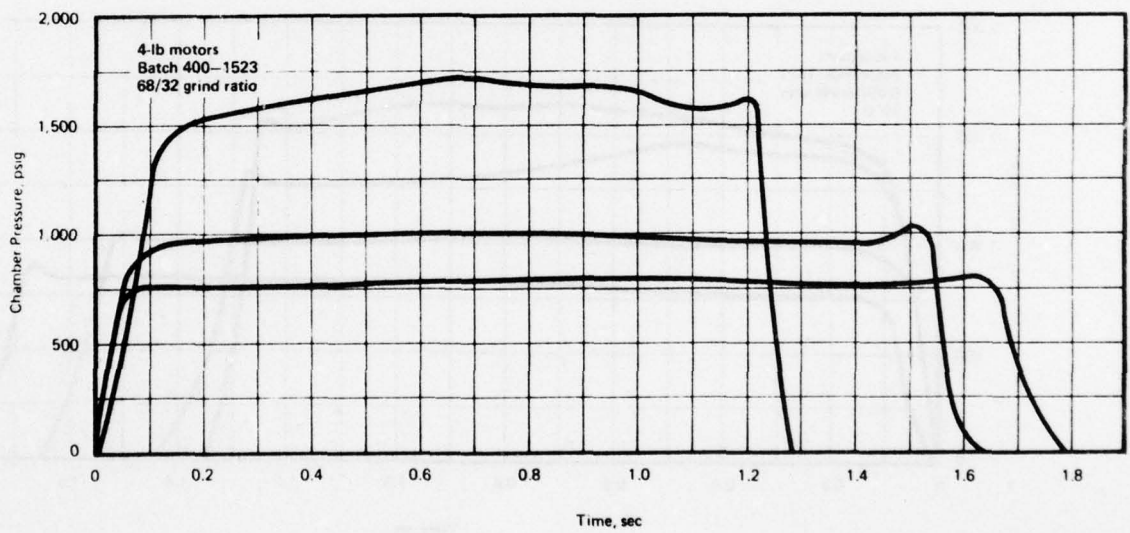
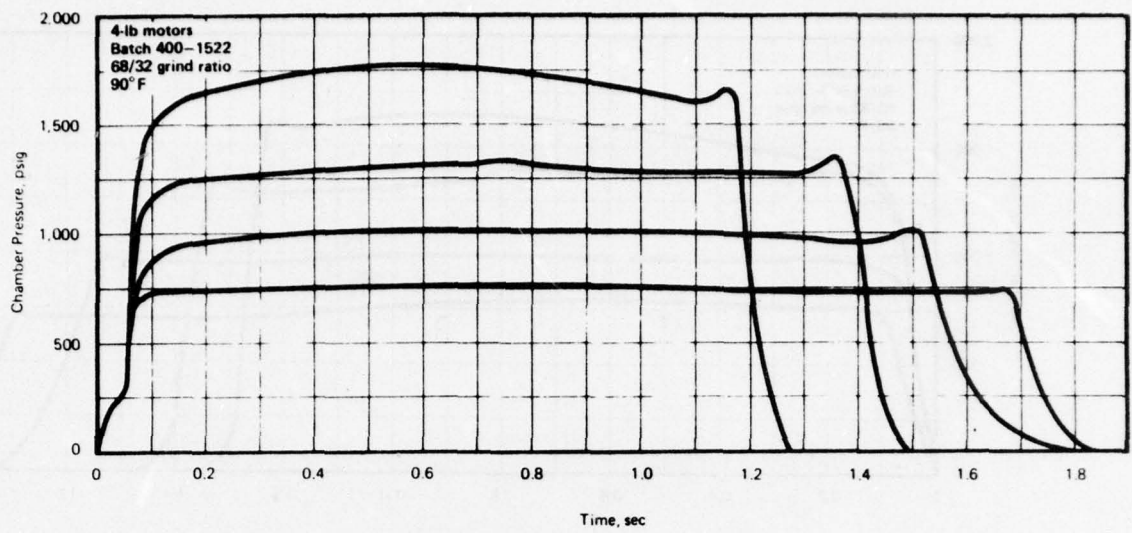


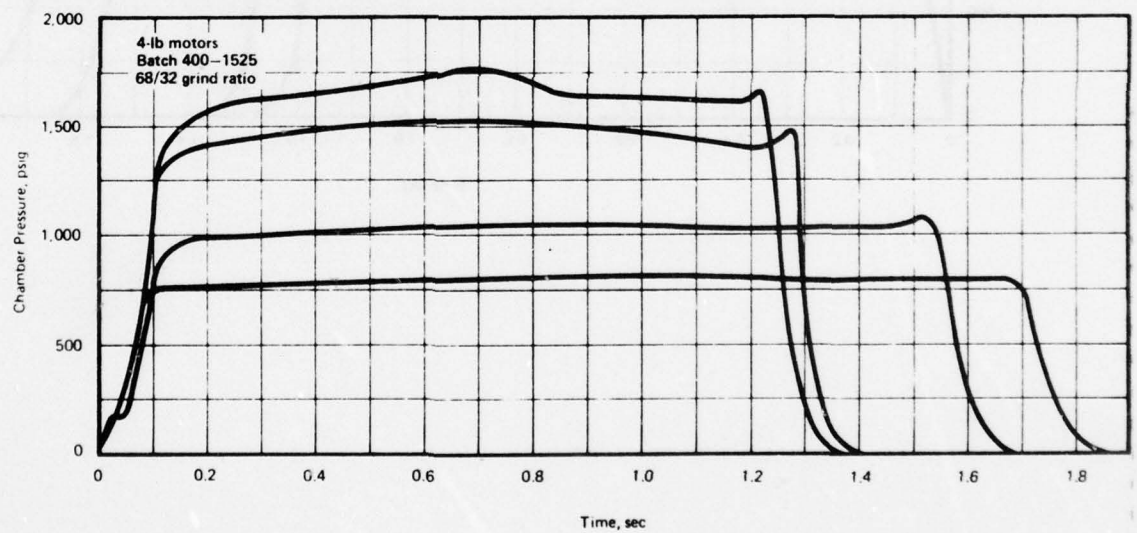
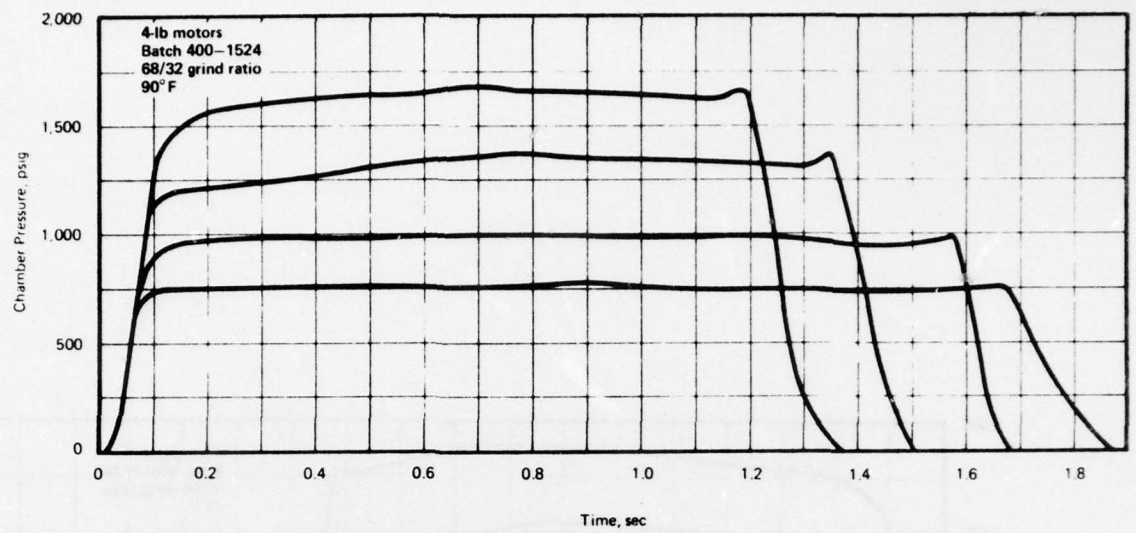












AD-A051 742

UNITED TECHNOLOGIES CORP SUNNYVALE CALIF CHEMICAL SY--ETC F/G 21/9.2
84-INCH PROPELLANT CARTRIDGES AND GRAINS. VOLUME II. PROPELLANT--ETC(U)
NOV 77 T V O'HARA, J B HENRY, W A STEPHEN F04611-76-C-0010
CSD-2579-FR AFRPL-TR-77-92 NL

UNCLASSIFIED

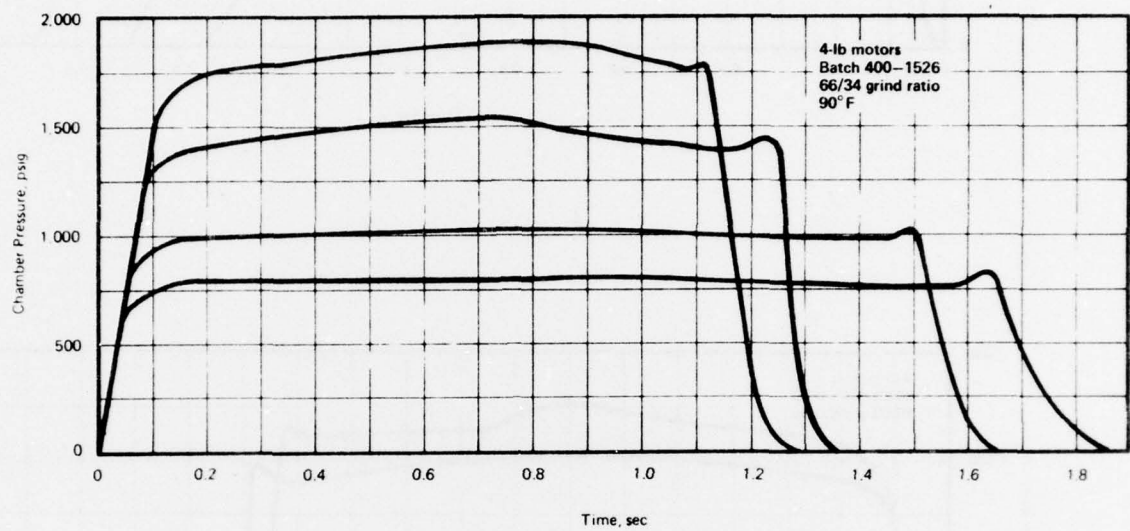
2 of 3
AD
A051 742



2 OF 3

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A051742





SECTION 2.9
PRODUCTION RUN NO. 5
(BATCHES 400-1527 THROUGH 400-1537)

PRODUCTION CASTING #5

UTP 18803A, 90°F
BATCHES 400-1527 THROUGH 1537
FOUR-POUND MOTORS 67/33 GRIND RATIO

<u>Batch</u>	<u>All Data r1000 r1400 41700</u>	<u>Pressure Exponent</u>	<u>One Standard Deviation, %</u>
400-1527	.4130 .4911 .5427	0.515	2.0
400-1528	.4180 .4878 .5332	0.459	0.7
400-1529	.4219 .5005 .5523	0.508	1.9
400-1530	.4222 .5016 .5441	0.512	0.6
400-1532	.4168 .4858 .5306	0.455	0.9
400-1533	.4192 .4847 .5271	0.431	0.6
400-1534	.4241 .4951 .5414	0.4599	0.9
400-1535	.4236 .4956 .5427	0.467	1.4
400-1536	.4213 .4955 .5442	0.482	0.04
400-1537	.4224 .5003 .5517	0.503	1.8
Composite	.4204 .4930 .5410	0.475	1.5

PRODUCTION CASTING #5

UTP 18803A FOUR-POUND MOTOR DATA
BATCHES 400-1527 THROUGH -1537
89°F

Batch	Burning Rates in./sec/Average Chamber Pressure, psia			
1527	.3976/901	.4268/1128	.4616/1229	.5392/1653
1528	.3680/761	.3936/865	.4612/1265	.5242/1619
1529	.3660/747	.4058/954	.5124/1447	.5378/1663
1530	.3709/767	.3936/886	.4875/1322	.5344/1581
1532	.3590/705	.3881/880	.4983/1477	.5280/1673
1533	.3610/698	.3908/866	.4722/1313	.5053/1538
1534	.3819/792	.4195/992	.5097/1452	.5445/1749
1535	.3707/777	.3989/855	.4804/1279	.5415/1723
1536	.4212/1000	.488/1355	.5582/1793	
1537	.3791/816	.4078/908	.5042/1487	.5778/1808

PRODUCTION CASTING #5

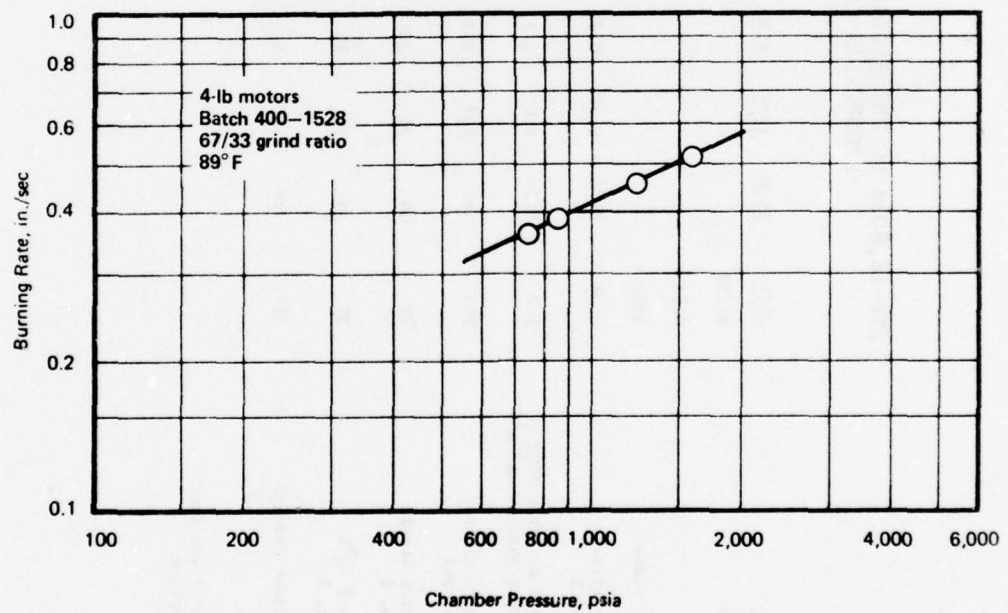
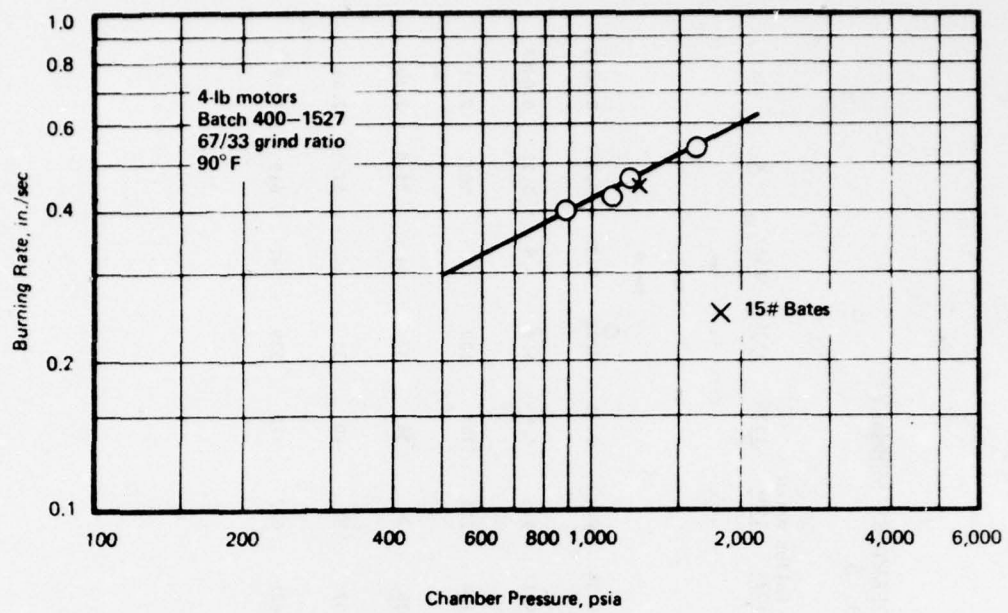
UTP 18803A
BATCHES 400-1527 THROUGH -1537
67/33 GRIND RATIO

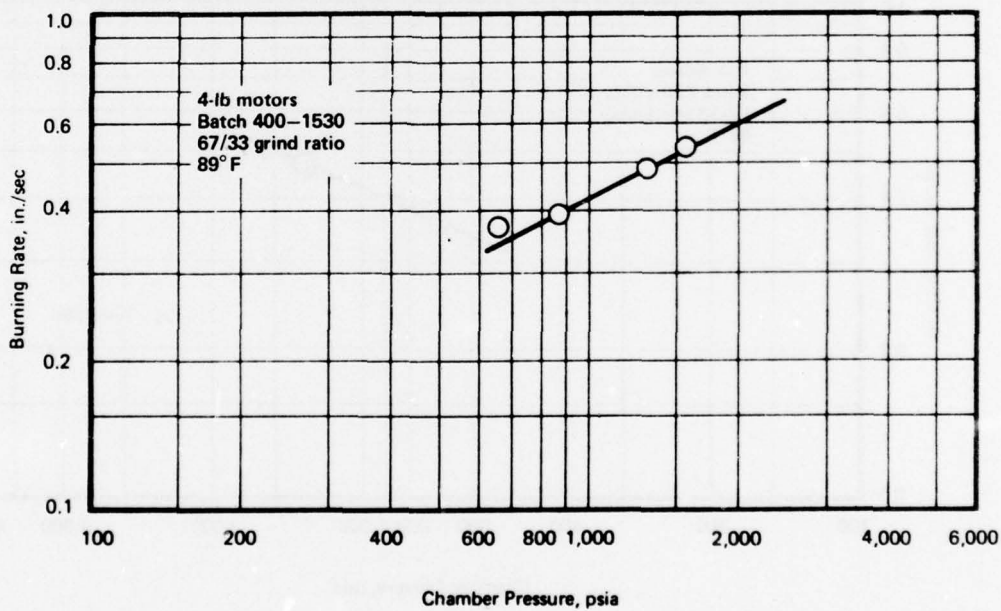
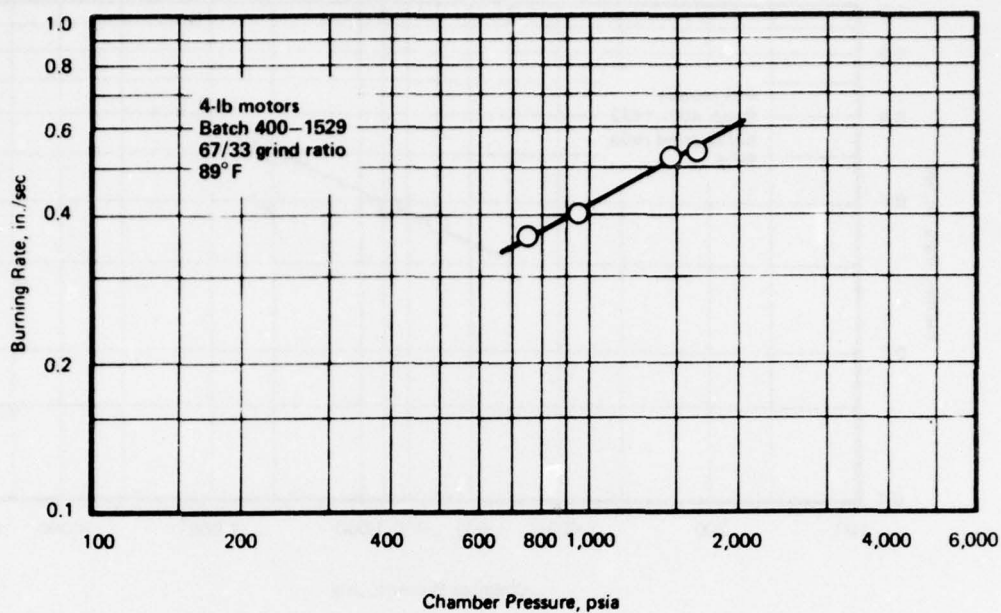
<u>Batch</u>		<u>Premix C</u>	<u>Final</u>
400-1527	1000	.485	.452
	1400	.616	.589
400-1528	1000	.483	.451
	1400	.627	.577
400-1529	1000	.490	.461
	1400	.626	.583
400-1530	1000	.479	.455
	1400	.618	.574
400-1532	1000	.474	.449
	1400	.608	.573
400-1533	1000	.478	.447
	1400	.609	.572
400-1534	1000	.481	.454
	1400	.613	.570
400-1535	1000	.474	.448
	1400	.608	.568
400-1536	1000	.485	.456
	1400	.617	.581
400-1537	1000	.482	.462
	1400	.616	.579

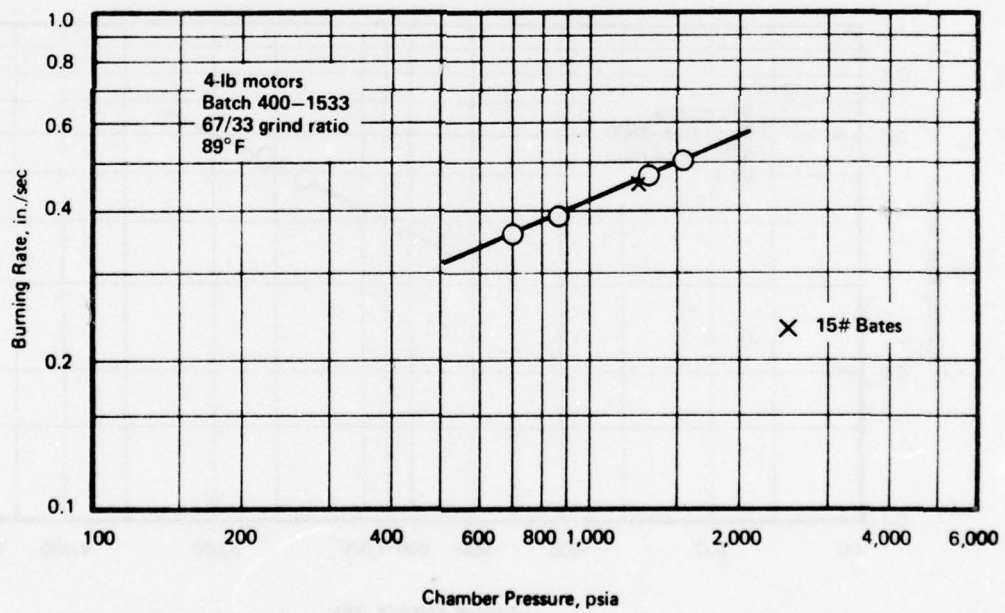
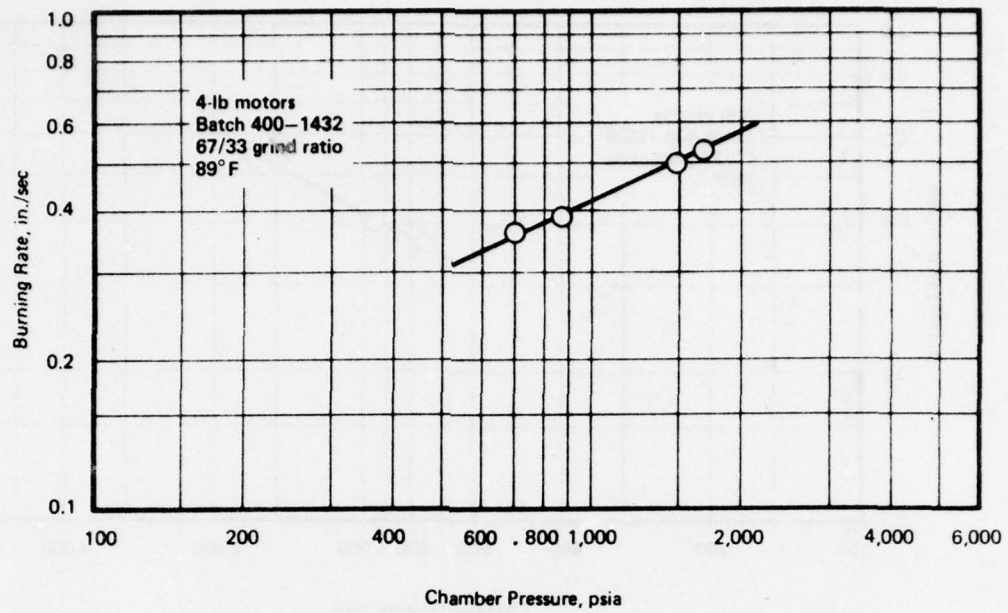
UTP-18, 803A QC PROCESSING AND PROPERTIES SUMMARY
PRODUCTION CASTING NO. 5

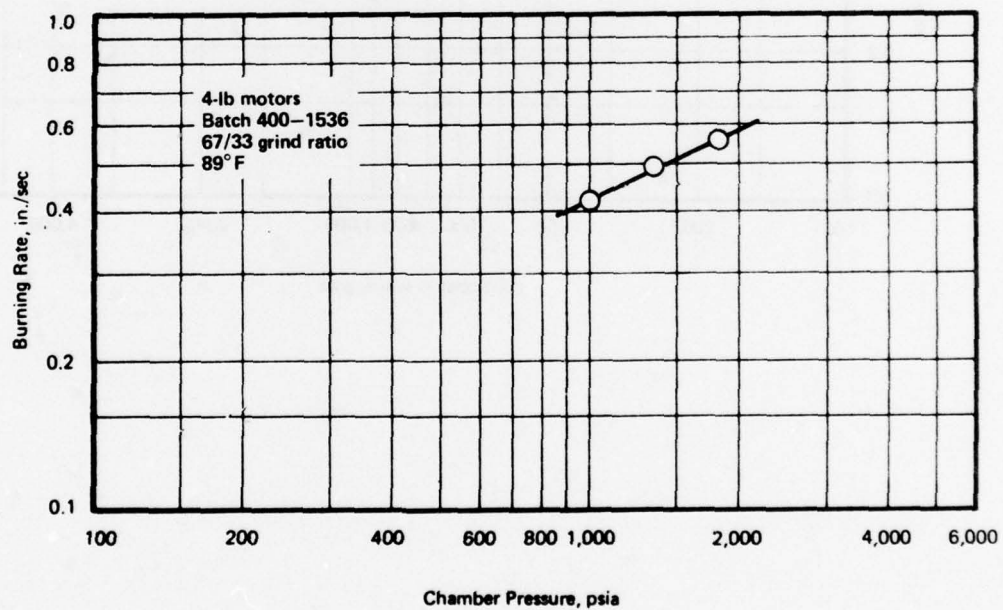
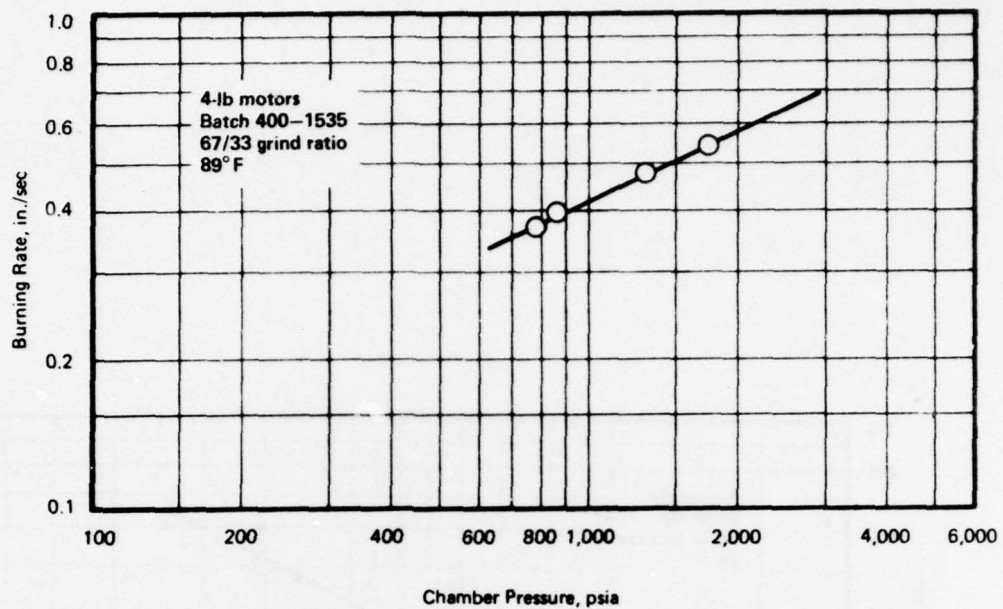
Parameter	1527	1528	1529	1530	1532	1533	1534	1535	1536	1537	\bar{x}	S_x
Grind ratio	67/33											
NCO/OH	0.81											
Fuel premix number	3500-5											
IPDI @ 1 hr after addition, wt %	0.38	0.38	0.38	0.36	0.38	0.38	0.40	0.36	0.38	0.37	0.377	0.0012
Viscosity @ 1 hr after IPDI ₂ addition, Kp @ 5000 dynes/cm ²	5.3	6.0	6.0	5.3	4.2	4.1	4.6	5.4	6.9	4.9	5.27	0.0087
Max. corrected stress @ 75°F, σ_m , psi	103	102	104	103	105	104	106	101	100	99	103	2.21
Max. corrected strain @ 75°F, ϵ_m , %	37	34	35	38	39	36	34	38	33	34	35.8	2.10
True strain @ 75°F rupture, ϵ_r , %	37	35	36	40	41	37	35	40	35	34	37.0	2.49
Initial tangent modulus E_0 , psi	717	728	592	614	553	621	617	478	529	741	619	87.9

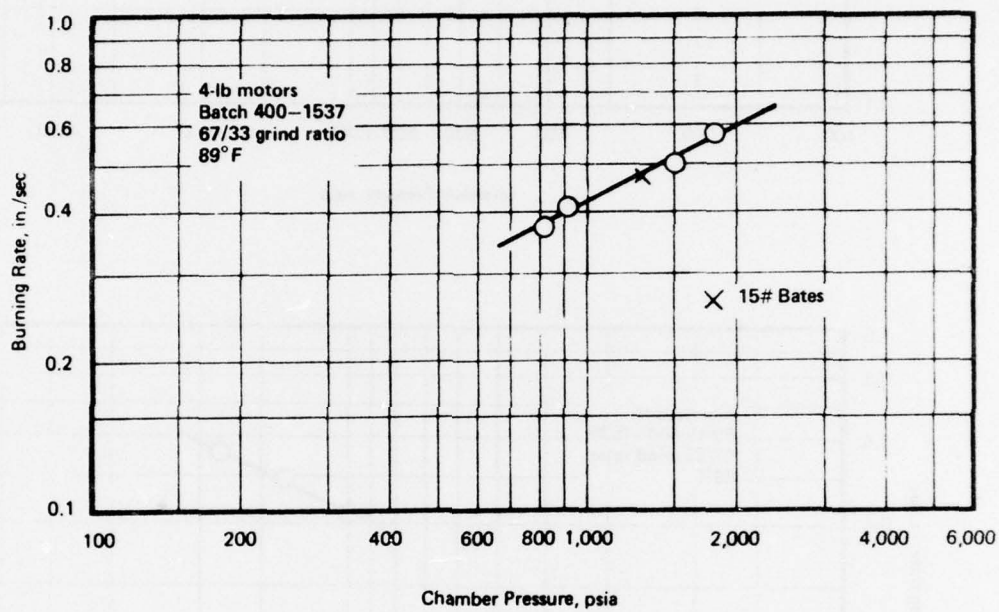
Batch 400-1531 was lost when fire system came on











SECTION 2.10
PRODUCTION RUN NO. 6
(BATCHES 400-1539 THROUGH 400-1543)

PRODUCTION CASTING #6

UTP 18803A 80 F
 BATCHES 400-1539 THROUGH 1543
 FOUR POUND MOTORS 67/33 GRIND RATIO

Batch	Burning Rate, $\frac{\text{in}}{\text{sec}}$	Pressure Exponent	One Standard Deviation, %
	r_{1000} r_{1400} r_{1700}		
400-1539	0.3937 0.4608 0.5047	0.468	0.4
400-1540	0.4114 0.4632 0.4935	0.353	0.8
400-1541	0.4170 0.4816 0.5234	0.428	1.1
400-1542	0.4054 0.4756 0.5216	0.475	0.3
400-1543	0.4072 0.4824 0.5319	0.503	1.8
Composite	0.4063 0.4728 0.5160	0.450	2.3

PRODUCTION CASTING #6

UTP 18803A FOUR POUND MOTOR DATA

BATCHES 400-1539 THROUGH 1543

80°F

<u>400 Gallon Batch</u>	<u>Burning Rate, in/sec</u>		<u>Chamber Pressure, psia</u>	
1539	.4092/1126	.3769/898	.4366/1241	.4554/1343
1540	.4195/1085	.4005/912	.45/1306	.4629/1366
1541	.3728/761	.418/1018	.4505/1232	.4832/1370
1542	.3551/761	.3954/941	.4654/1342	.4838/1451
1543	.3643/780	.396/982	.4606/1306	.500/1456

PRODUCTION CASTING #6

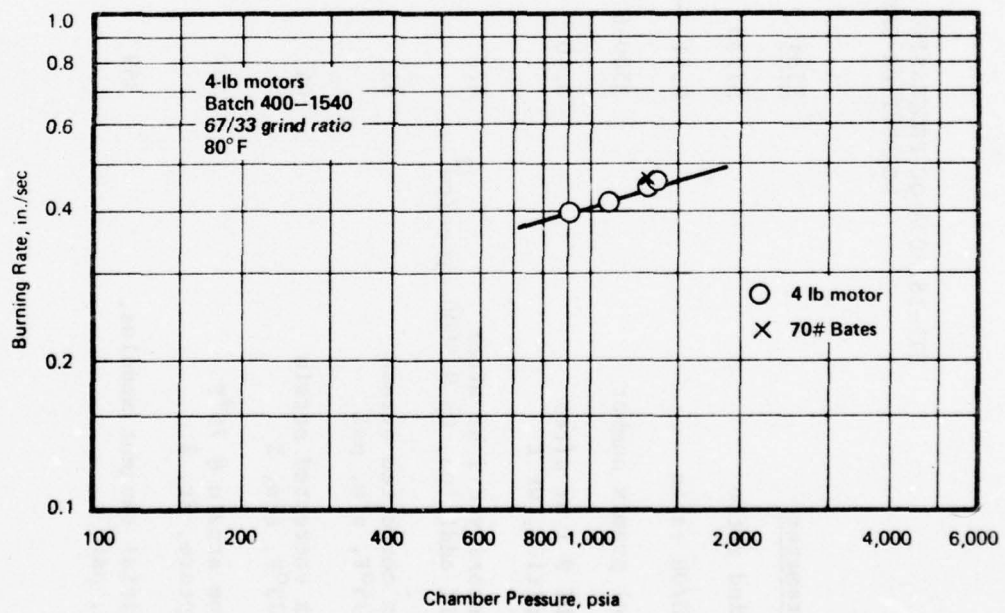
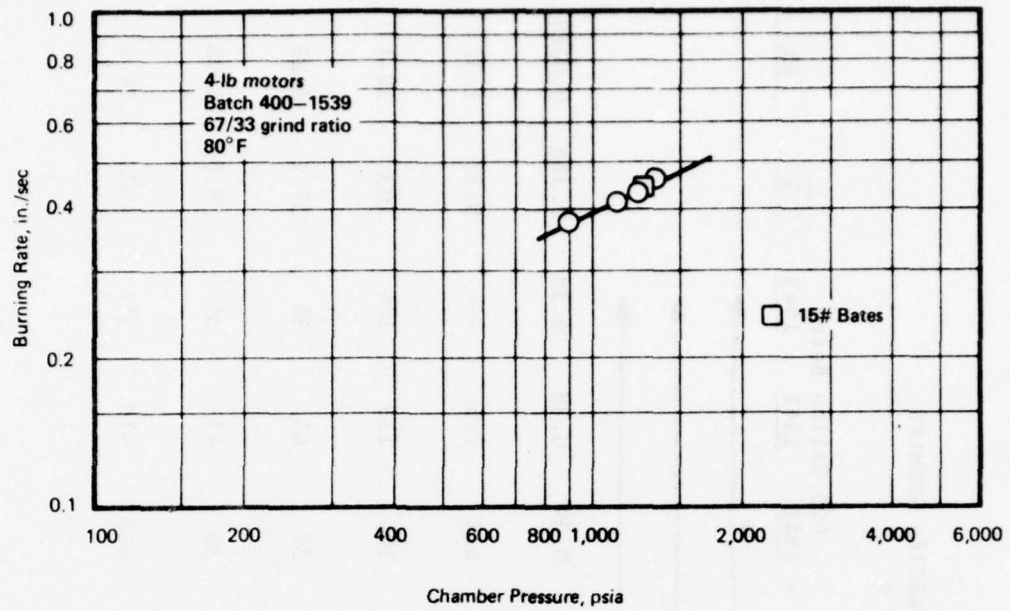
UTP 18803A

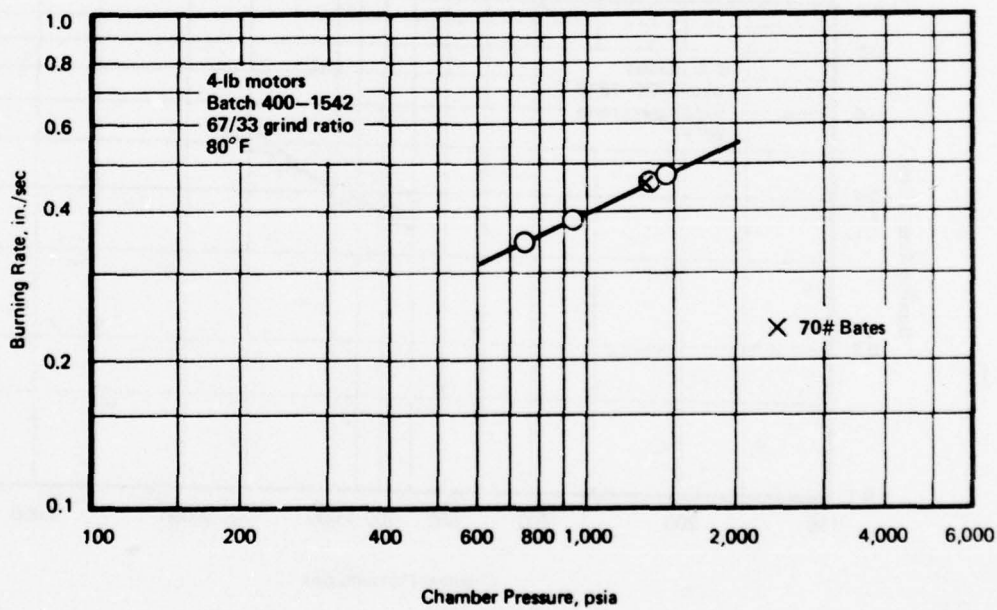
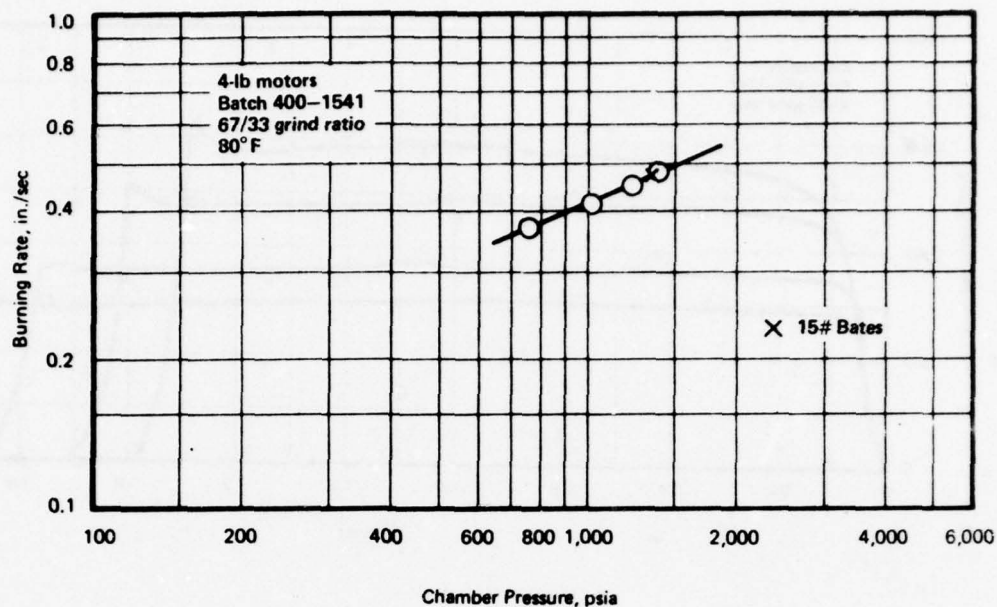
67/33 GRIND RATIO

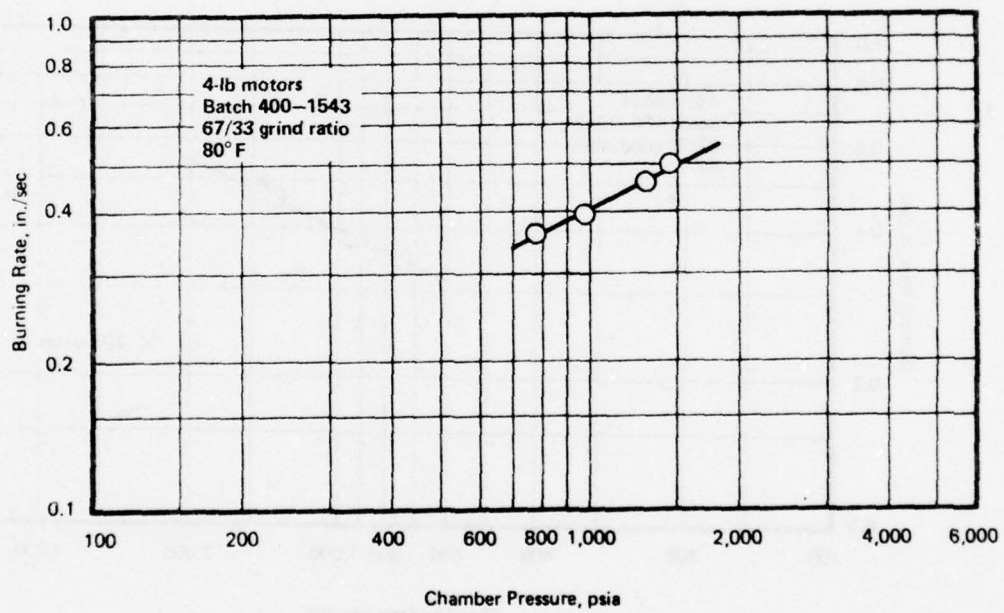
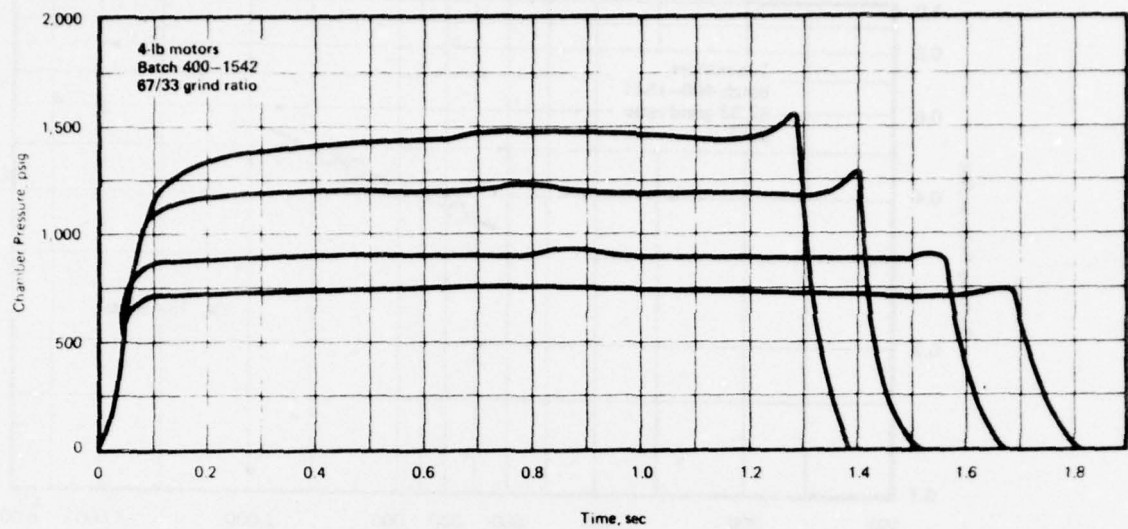
<u>Batch</u>		<u>Premix C</u>	<u>Prop</u>
400-1539	1000	.478	.448
	1400	.619	.569
400-1540	1000	.481	.451
	1400	.612	.574
400-1541	1000	.481	.452
	1400	.615	.572
400-1542	1000	.477	.452
	1400	.610	.574
400-1543	1000	.485	.457
	1400	.622	.576

UTP-18,803A QC PROCESSING AND PROPERTIES SUMMARY
PRODUCTION CASTING NO. 6

Parameter	1539	1540	1541	1542	1543	\bar{X}	Sx
Grind ratio	67/33						
NCO/OH ratio	0.81						
Fuel premix number	3500-6						
IPDI @ 1 hr after addition, wt %	0.40	0.38	0.39	0.38	0.38	0.386	0.0089
Viscosity @ 1 hr after IPDI addition, Kp @ 5000 dynes/cm ²	4.7	4.6	6.1	7.5	---	5.73	1.37
Max corrected stress @ 75°F, σ_c , psi	91	97	105	118	104	103	10.1
Max corrected strain @ 75°F, ϵ_c , %	44	29	35	43	35	37.2	6.26
True strain @ 75°F rupture, Er, %	46	29	36	44	35	38.0	6.96
Initial tangent modulus, Eo, psi	359	489	446	416	556	453	74.4







SECTION 2.11
PRODUCTION RUN NO. 7
(BATCHES 400-1546 THROUGH 400-1557)

PRODUCTION CASTING #7

UTP 18803 A 72 F

BATCHES 400-1546 THROUGH 1557

FOUR POUND MOTORS 68/32 GRIND RATIO

Batch	Burning Rate, $\frac{\text{in}}{\text{sec}}$	Pressure Exponent	One Standard Deviation, %
	$\frac{\text{r1000}}{\text{r1400}} \frac{\text{r1700}}$		
1546	.4088	.365	1.6
	.4622		
	.4961		
1547	.4145	.461	1.0
	.4841		
	.5294		
1548	.4065	.476	0.9
	.4770		
	.5232		
1549	.4056	.449	0.9
	.4717		
	.5146		
1550	.4069	.474	0.9
	.4773		
	.5233		
1551	.4096	.464	1.5
	.4790		
	.5240		
1552	.4054	.468	1.4
	.4746		
	.5197		
1553	.4037	.480	1.5
	.4745		
	.5209		
1554	.4080	.483	1.1
	.4800		
	.5271		
1555	.4112	.461	2.2
	.4802		
	.5252		
1556	.3999	.496	1.8
	.4726		
	.5204		

PRODUCTION CASTING #7

1557	.3984		
	.4665	.469	1.5
	.5110		
Composite	.4061		
	.4756	.469	1.7
	.5209		

PRODUCTION CASTING #7

UTP 18803A FOUR POUND MOTOR DATA

BATCHES 400-14546-1557

68/32 GRIND RATIO

72 F

<u>400 Gallon Batch</u>	<u>Burning Rate, in sec/Chamber Pressure, psia</u>
1546	.3984/916, .4336/1235, .4733/1447
1547	.4049/942, .4578/1271, .5037/1502
1548	.3527/739, .3868/896, .4329/1177, .4864/1434
1549	.3567/737, .3849/911, .4387/1200, .4833/1459
1550	.3545/740, .3913/924, .4353/1181, .4921/1467
1551	.356/746, .3953/899, .4362/1192, .4979/1494
1552	.3545/749, .3927/921, .4368/1222, .4947/1492
1553	.3602/766, .3806/900, .4256/1156, .5120/1590
1554	.362/767, .3836/907, .4524/1220, .5148/1622
1555	.3644/787, .410/938, .4397/1217, .5255/1675
1556	.3525/753, .387/959, .4388/1252, .5163/1619
1557	.3645/747, .3464/731, .4137/1124, .493/1542

PRODUCTION CASTING #7

LSBR DATA

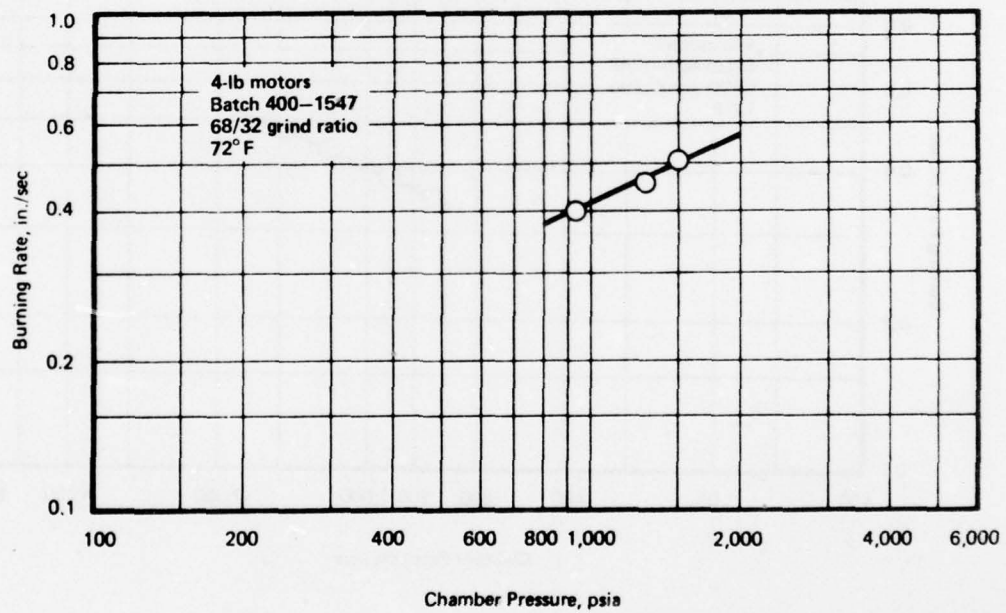
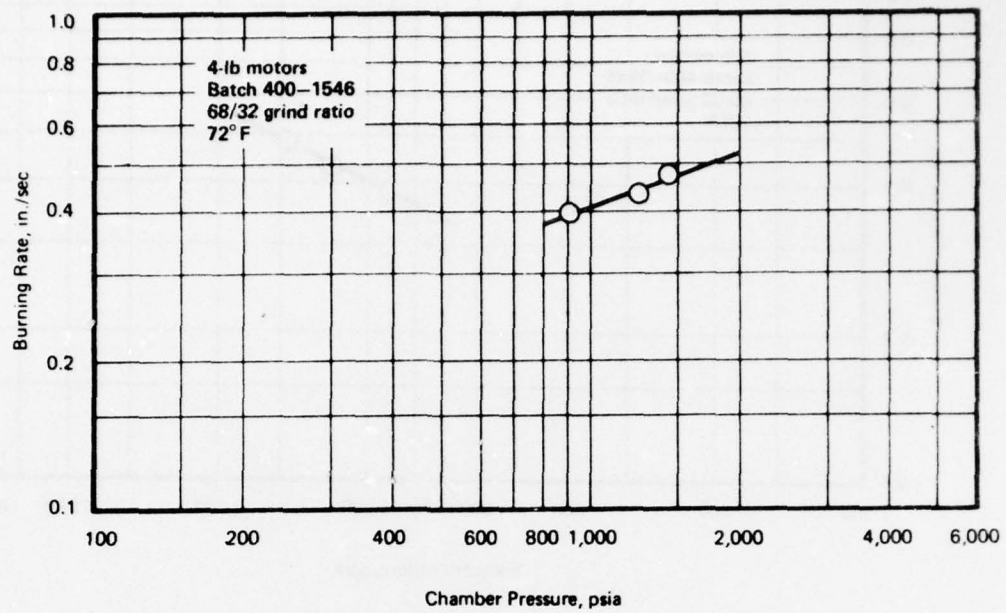
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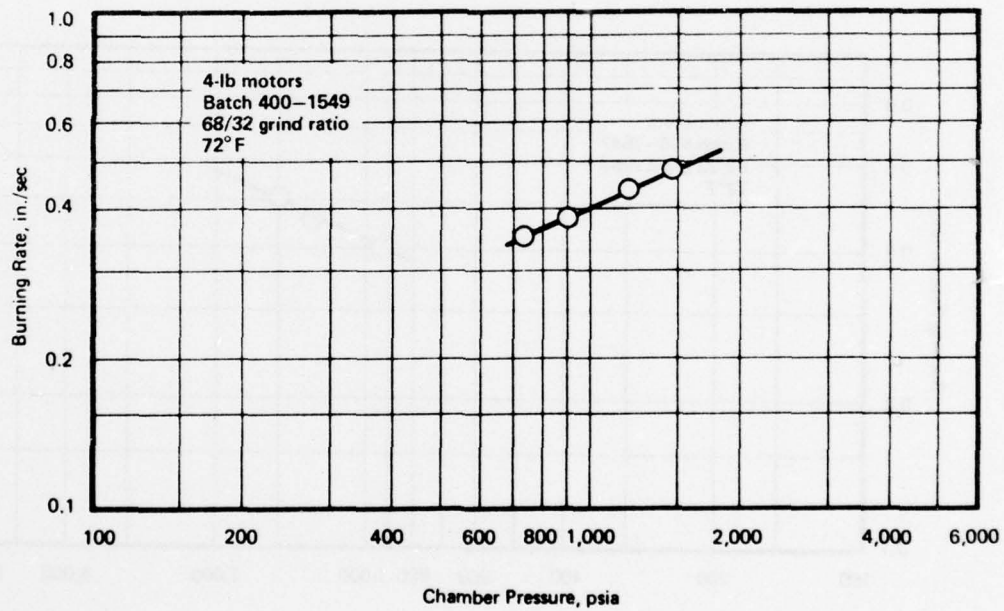
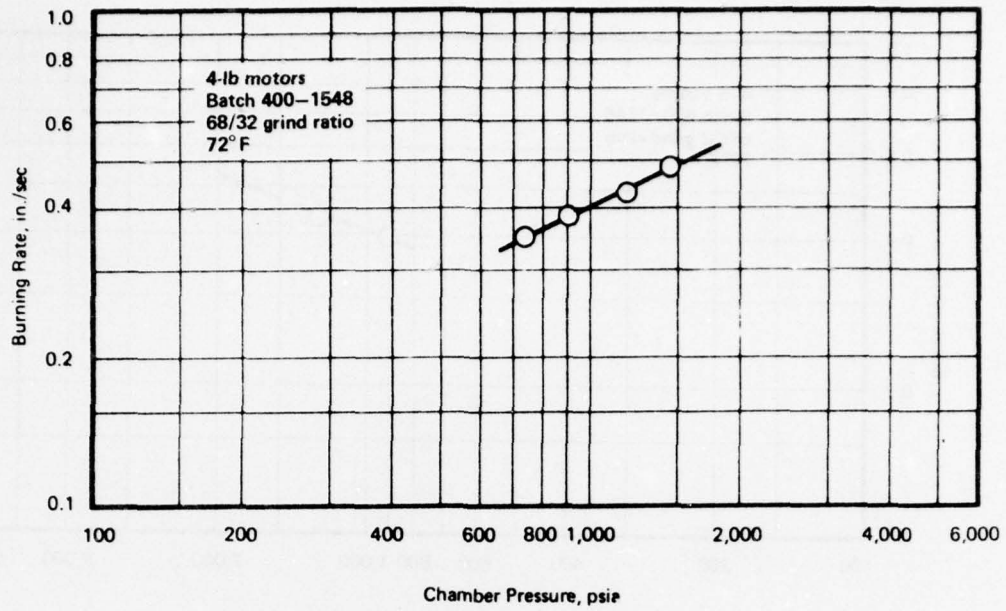
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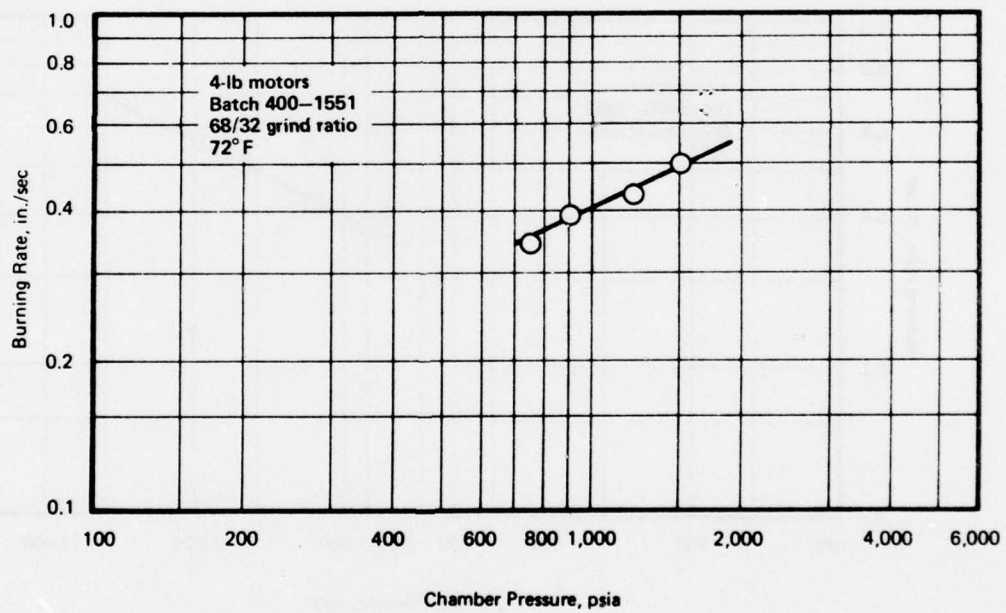
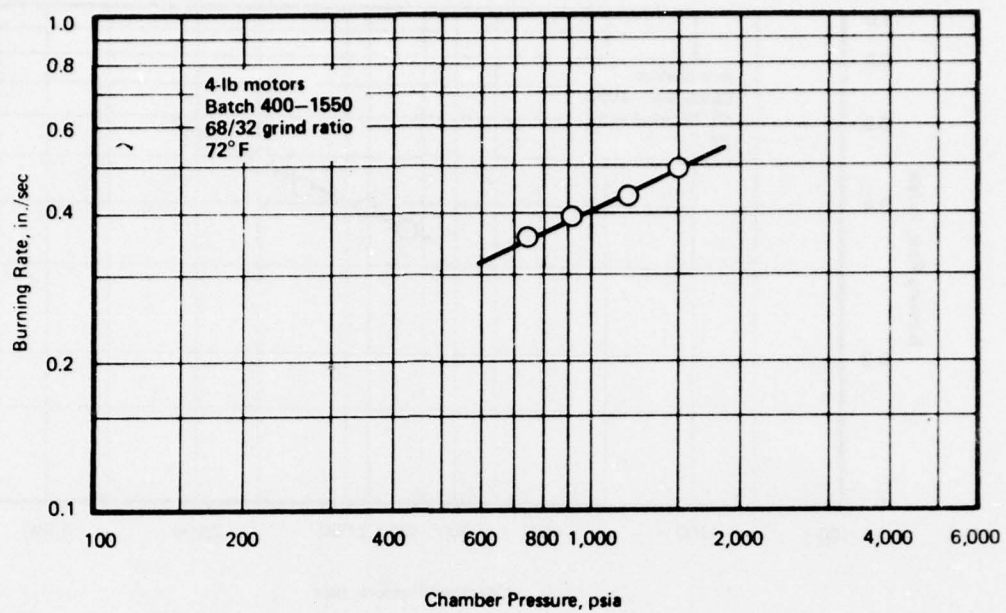
<u>Batch</u>	<u>Premix C</u>	<u>Final</u>
400-1546	.484 .619	.461 .576
400-1547	.492 .624	.465 .584
400-1548	.487 .623	.457 .577
400-1549	.482 .620	.458 .579
400-1550	.484 .609	.454 .573
400-1551	.479 .607	.454 .574
400-1552	.480 .607	.453 .570
400-1553	.481 .615	.456 .576
400-1554	.478 .611	.458 .578
400-1555	.490 .623	.465 .585
400-1556	.480 .612	.453 .574
400-1557	.474 .604	.450 .571

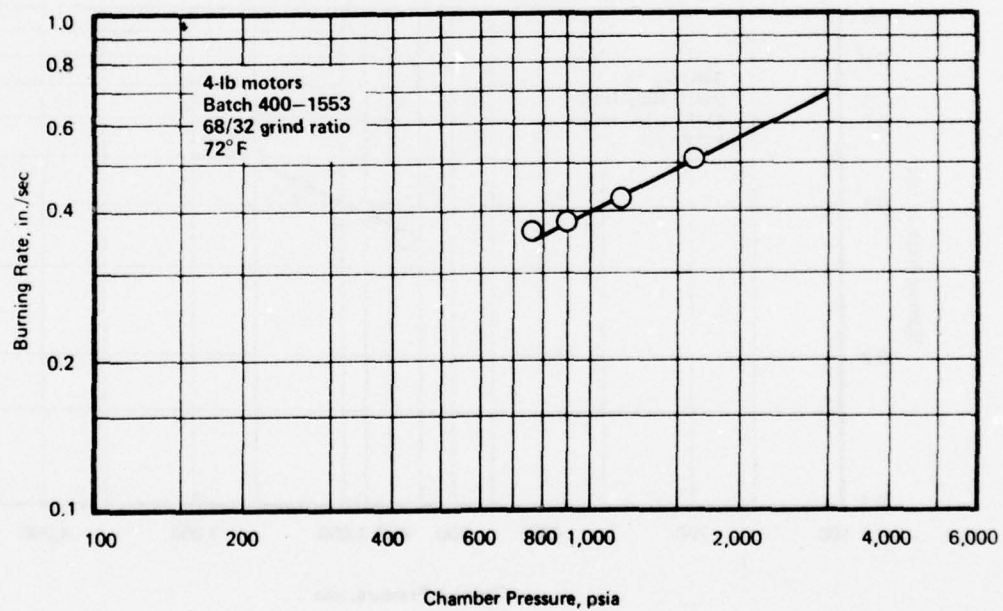
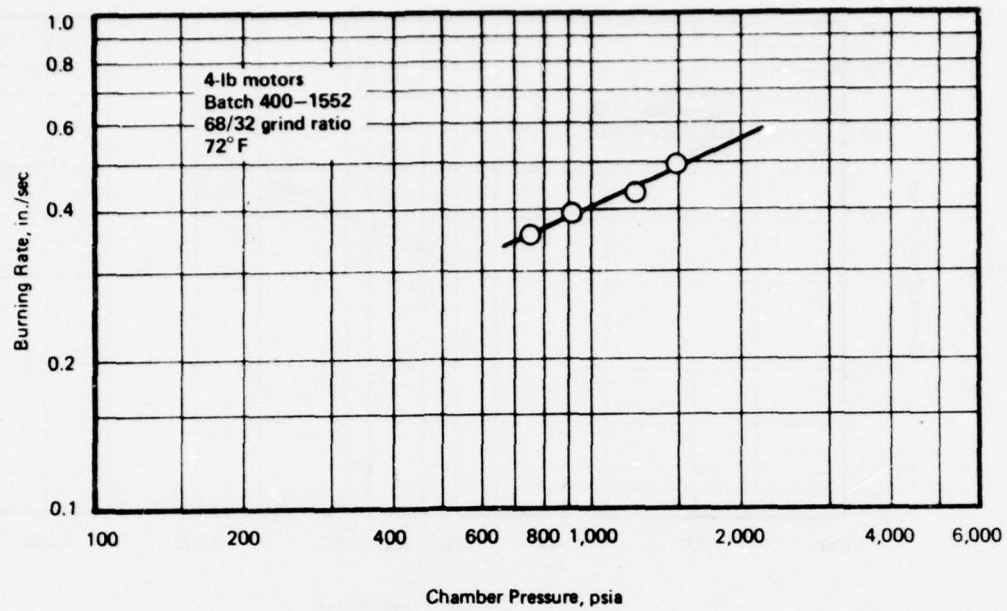
UTP-18, 803A QC PROCESSING AND PROPERTIES SUMMARY
PRODUCTION CASTING NO. 7

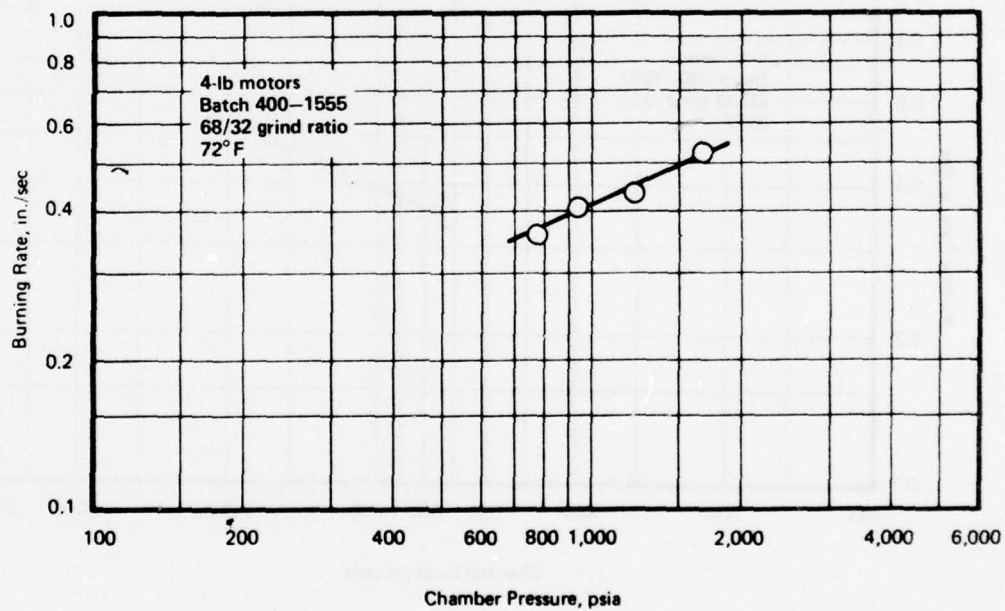
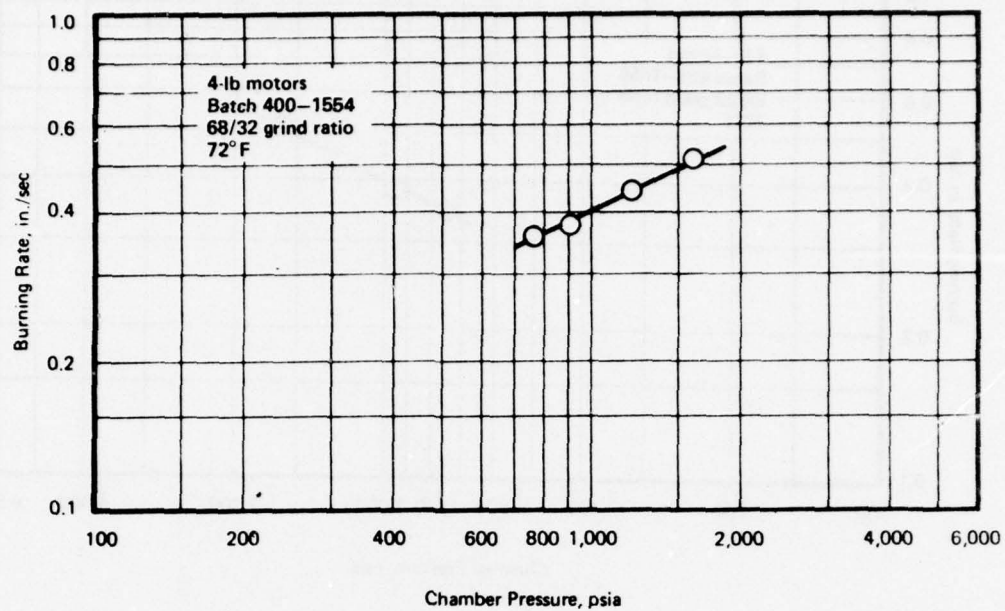
Parameter	1546	1547	1548	1549	1550	1551	1552	1553	1554	1555	1556	1557	\bar{x}	Sx
Grind ratio	68/32													
NCO/OH ratio	0.82													
Fuel Premix number	3500-6													
IPDI @ 1 hr after addition, wt %	0.40	0.40	0.38	0.38	0.37	0.38	0.38	0.38	0.38	0.38	0.40	0.38	0.384	0.0099
Viscosity @ 1 hr after IDPI addition, Kp @ 5000 dynes/cm ²	6.16	4.14	4.54	4.97	5.34	5.05	7.12	5.72	5.83	6.10	5.43	5.12	5.46	0.008
Max corrected stress @ 75°F, σ^c_m , psi	134	134	136	131	124	107	104	102	105	122	121	102	119	13.7
Max corrected strain @ 75°F, ϵ^c_m , %	37	32	35	33	35	24	24	22	18	28	34	39	30.1	6.69
Initial tangent modulus, E_o , psi	592	706	645	821	726	1056	812	891	1081	875	834	638	806	156
True strain @ 75°F fupture, E_f , %	37	34	36	34	36	25	26	23	20	29	34	40	31.2	6.35

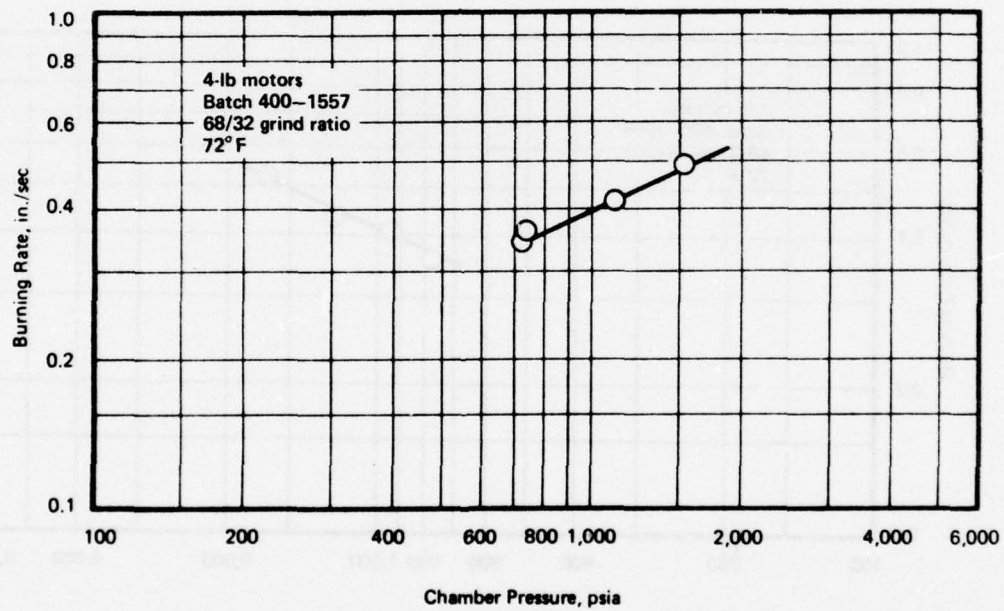
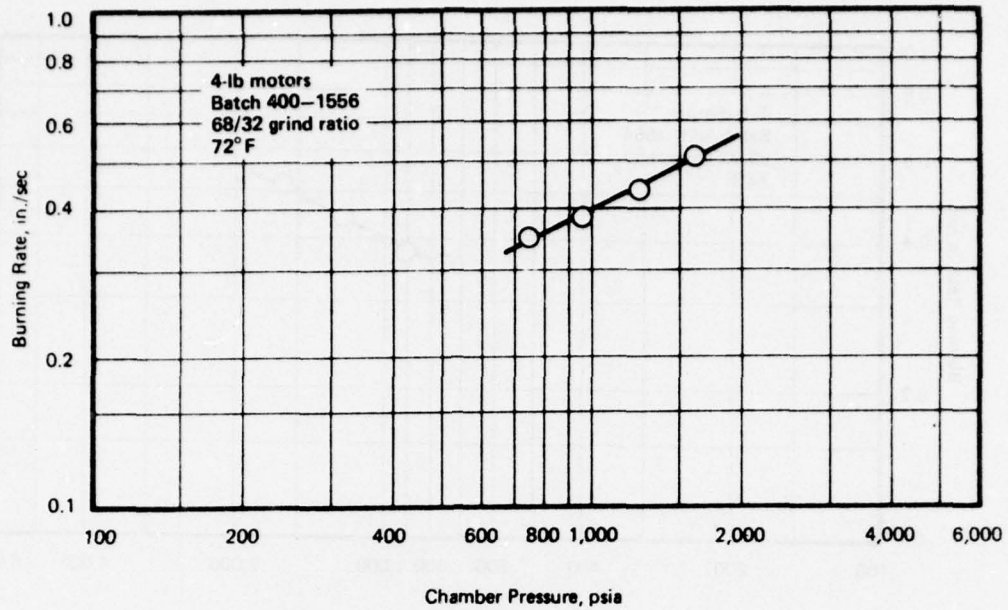


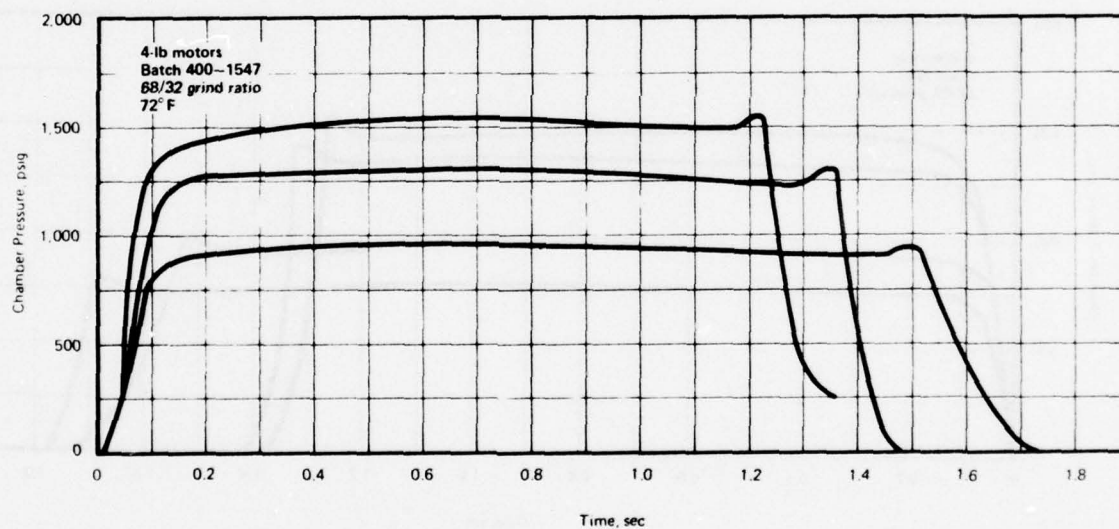
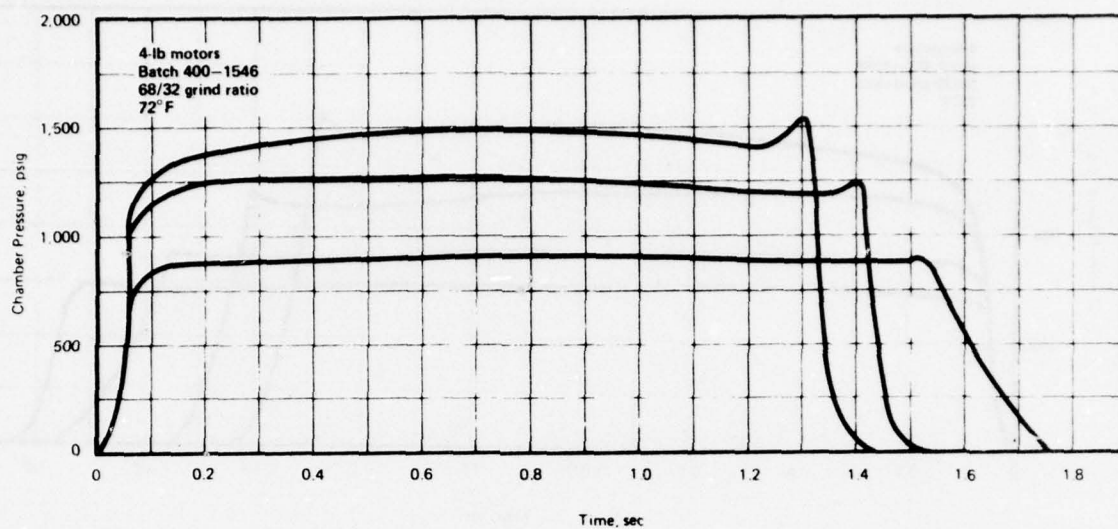


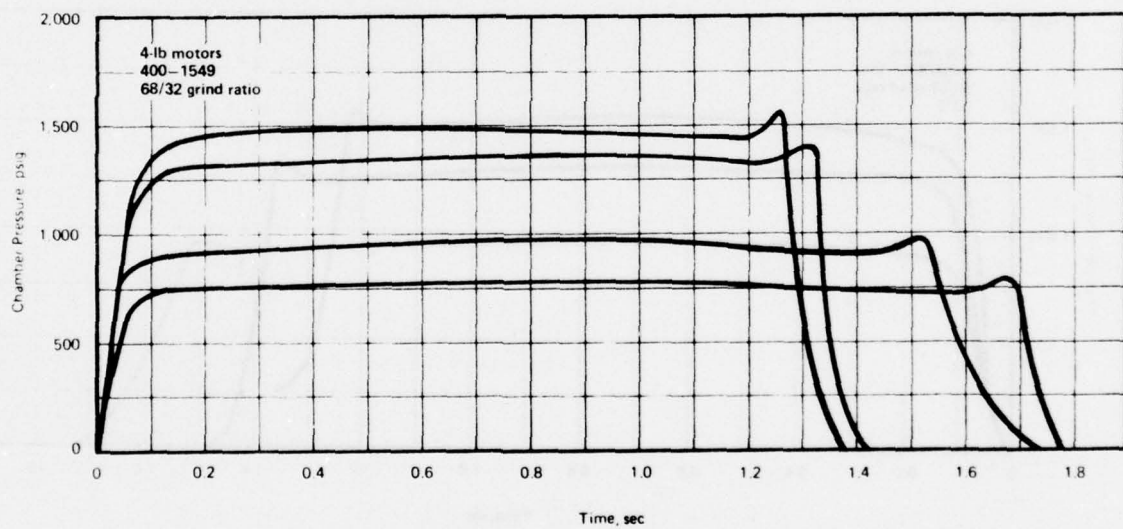
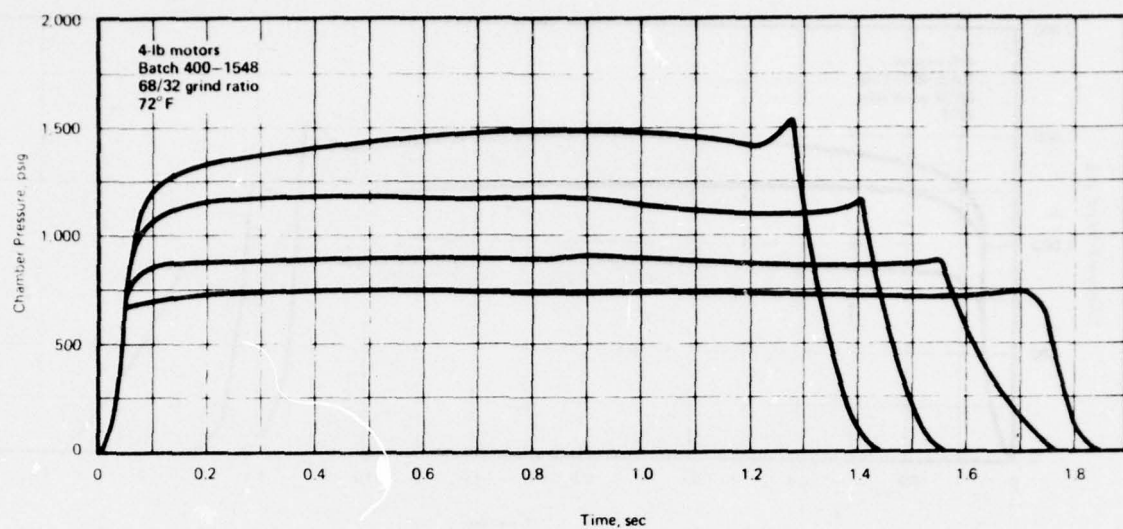


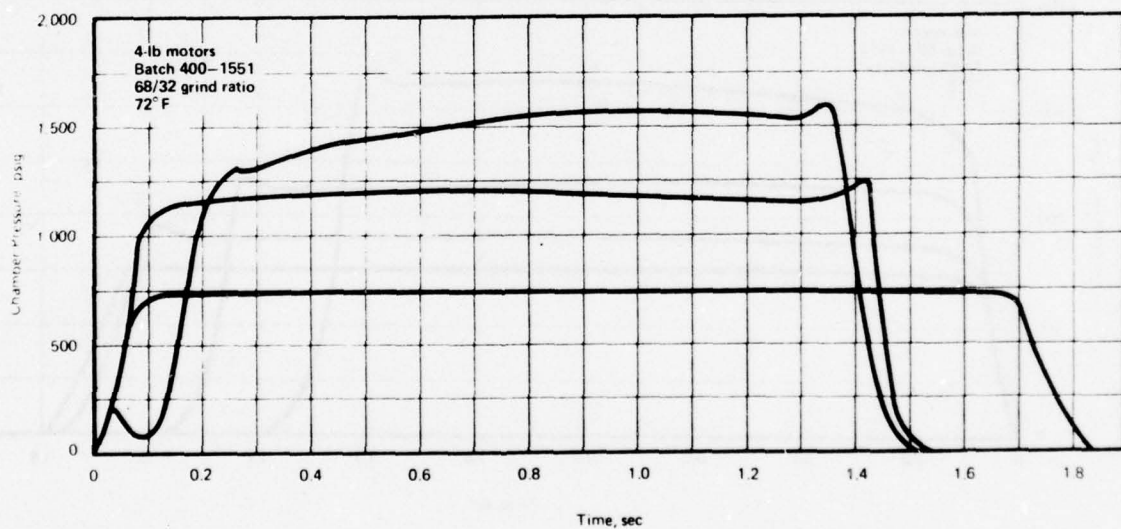
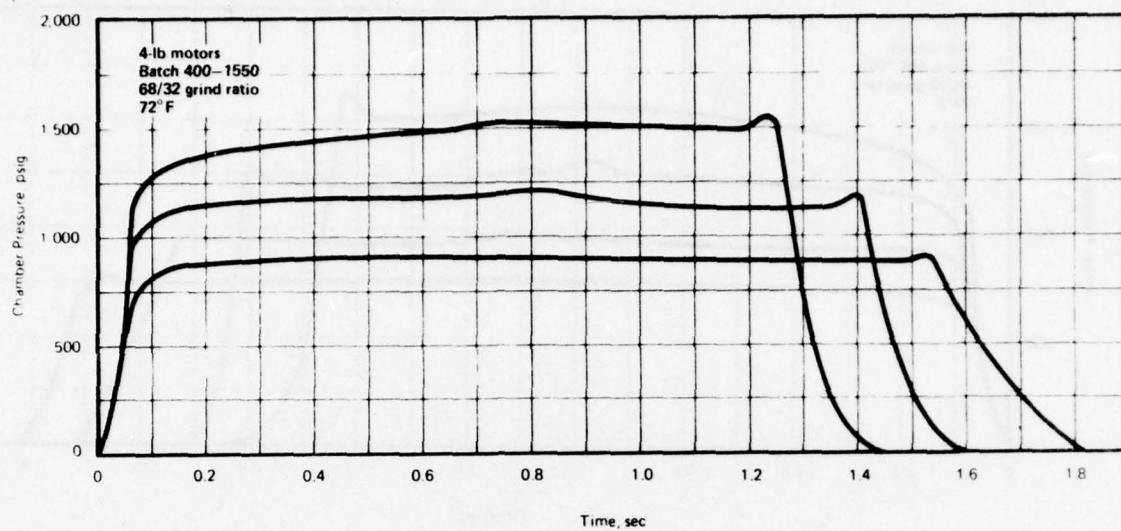


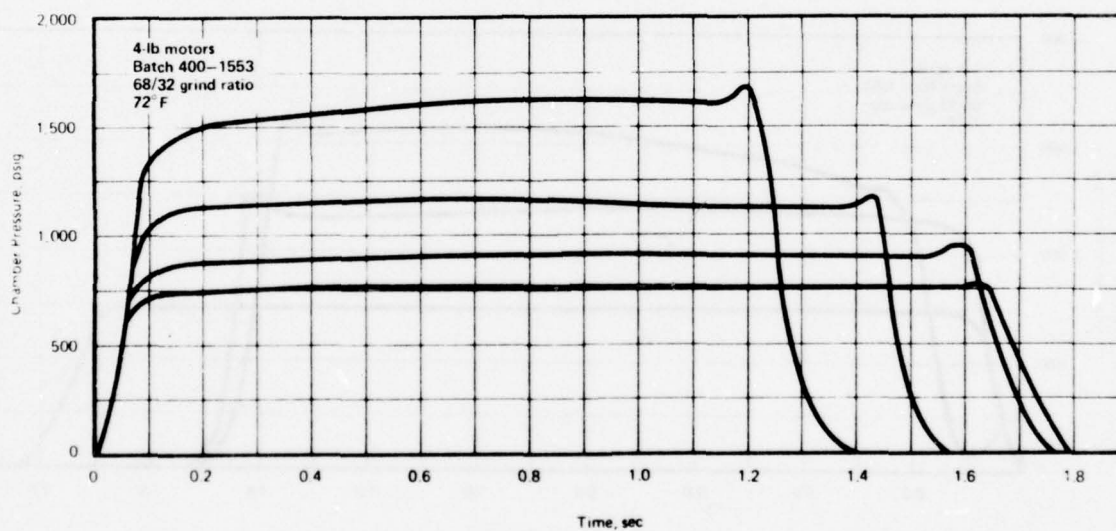
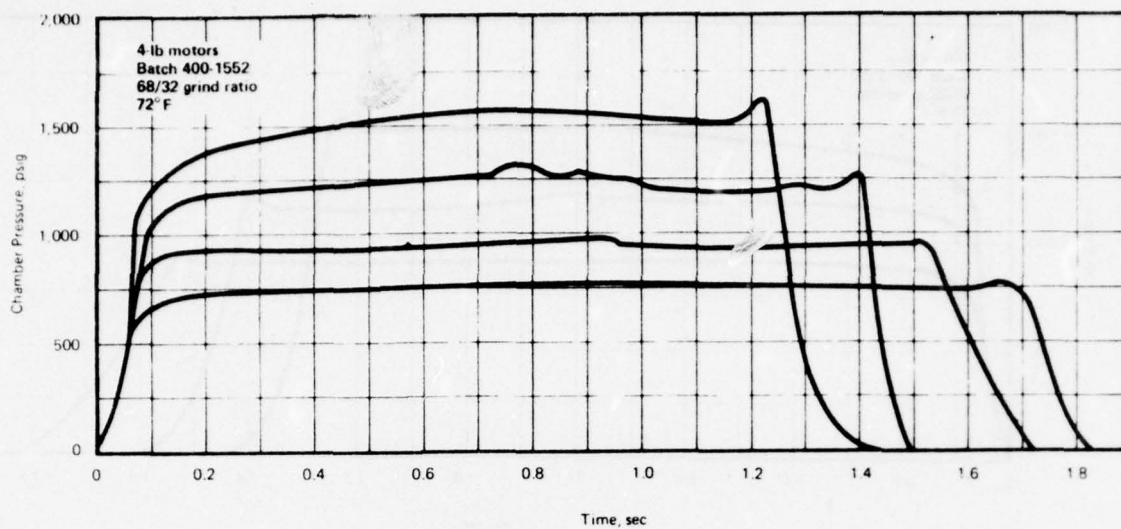


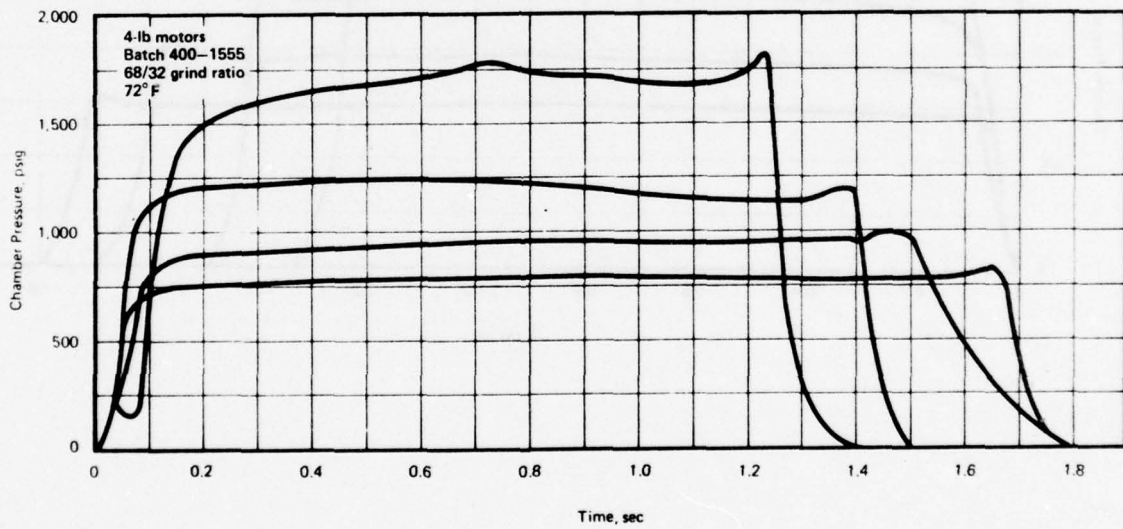
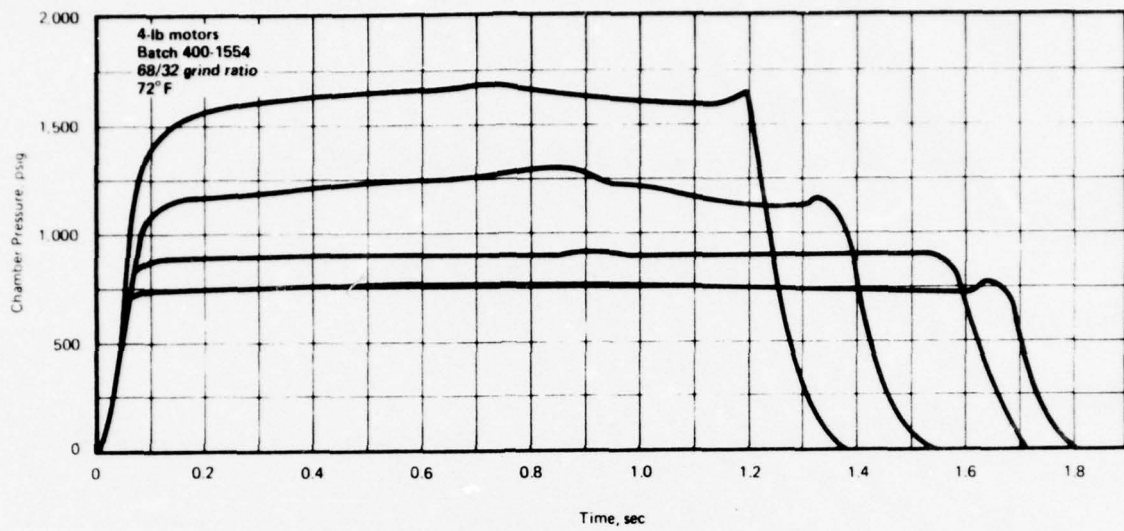


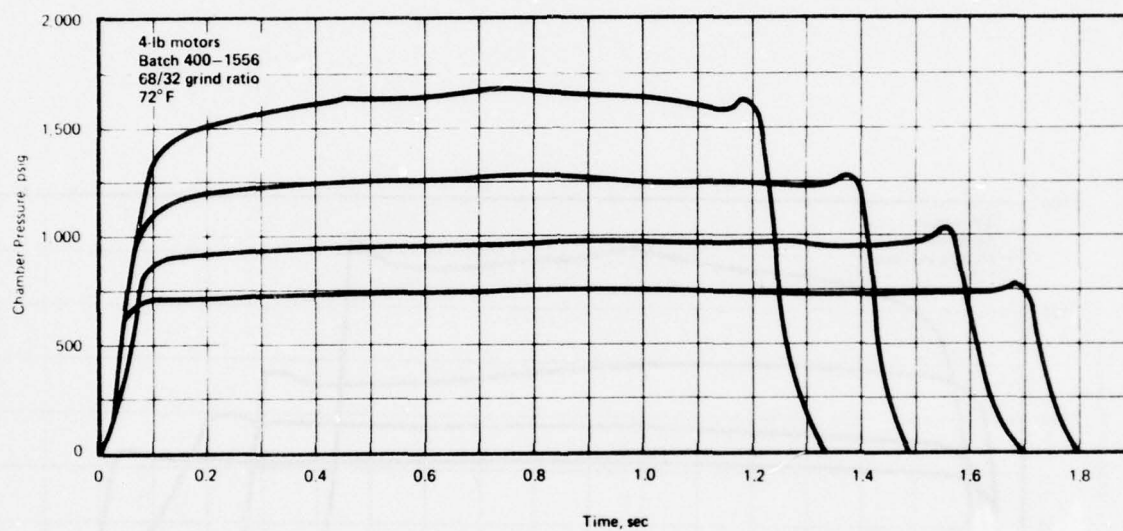












SECTION 2.12
PRODUCTION RUN NO. 8
(BATCHES 400-1574 THROUGH 400-1582)

PRODUCTION CASTING #8
 UTP 18803A 67/33 GRIND RATIO AND 0.81 NCO/OH RATIO
 FOUR POUND MOTORS 80 F

<u>Batch</u>	<u>Burning Rate, in/sec</u>			<u>Exponent</u>	<u>σ, %</u>
	<u>1000 psia</u>	<u>1400 psia</u>	<u>1700 psia</u>		
400-1574	.3933	.4606	.5045	.469	0.9
400-1575	.3925	.4702	.5218	.537	0.8
400-1576	.3946	.4706	.5210	.523	1.5
400-1577	.3982	.4710	.5189	.499	0.7
400-1578	.3971	.4705	.5189	.504	1.0
400-1579	.3991	.4813	.5362	.557	1.1
400-1580	.3964	.4740	.5255	.532	1.9
400-1581	.3944	.4730	.5252	.539	0.5
00-1582	.3996	.4720	.5197	.495	0.7
Composite	.3956	.4720	.5226	.525	1.45

PRODUCTION CASTING #8
 UTP 18803A 67/33 GRIND RATIO AND .81 NCO/OH RATIO
 FOUR POUND MOTOR DATA, 80°F

<u>Batch</u>	<u>Burning Rate, in/sec/Chamber pressure, psia</u>
400-1574	.3798/927, .4523/1336, .4718/1447, .4523/1385*
400-1575	.3789/941, .504/1585, .5065/1647, .4736/1405, .4994/1547*
400-1576	.3798/925, .5238/1652, .4869/1511, .4894/1501, .4879/1557*
400-1577	.3874/948, .5046/1648, .5218/1700, .4839/1468, .4955/1536*
400-1578	.3888/962, .5016/1534, .5053/1640, .505/1628, .4817/1473*
400-1579	.3934/970, .5223/1605, .5566/1819, .5067/1506, .4799/1441*
400-1580	.396/982, .4949/1465, .5306/1708, .461/1340, .455/1372*
400-1581	.386/965, .459/1320, .5367/1777, .457/1326, .459/1305*
400-1582	.395/971, .4629/1357, .5258/1727, .454/1320, .4624/1324*

All four motors used a fiberglass cartridge except those identified by * which were steel cartridges.

UTP 18803A
PRODUCTION CASTING #8
TABLE I - LSBR DATA

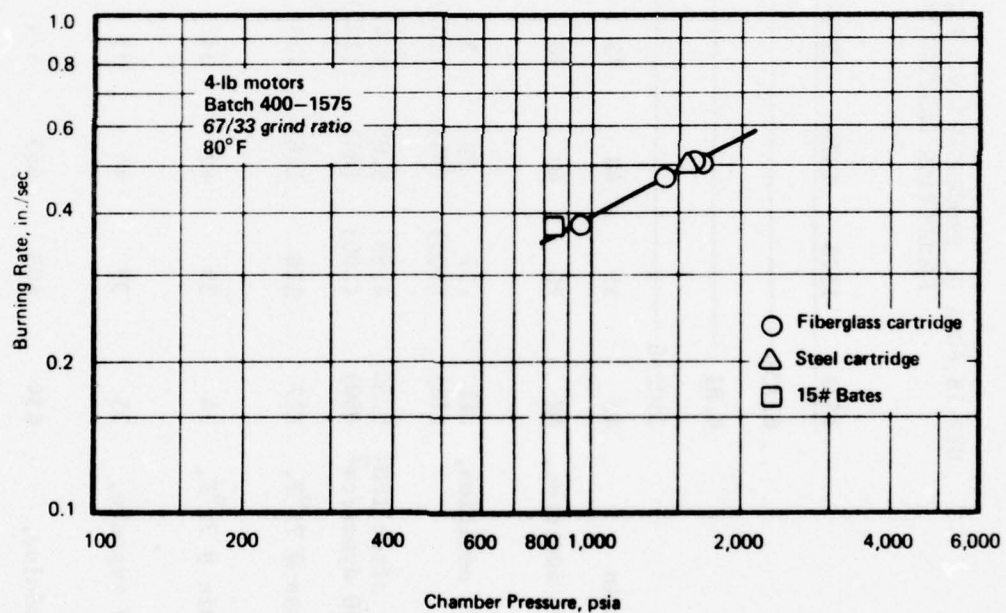
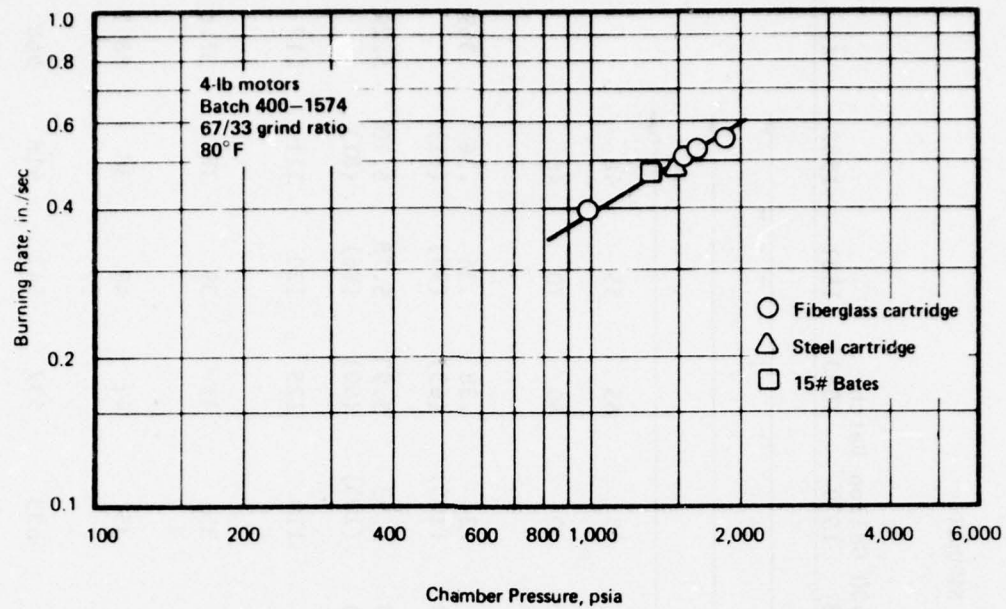
<u>Batch No.</u>	<u>AP Addition Time, min</u>	<u>Mix Time After IPDI Addition, min</u>	<u>Pressure</u>	<u>Premix C</u>	<u>Final</u>
400-1574	43	40	1000 1400	0.490 0.623	0.475 0.598
400-1575	55	70	1000 1400	0.505 0.643	0.448 0.582
400-1576	40	40	1000 1400	0.482 0.616	0.451 0.577
400-1577	75	70	1000 1400	0.480 0.612	0.477* 0.565
400-1578	35	40	1000 1400	0.480 0.610	0.452 0.569*
400-1579	55	70	1000 1400	0.491 0.619	0.452 0.577
400-1580	65	40	1000 1400	0.490 0.618	0.450 0.576
400-1581	55	70	1000 1400	0.486 0.615	0.452 0.566*
400-1582	48	40	1000 1400	0.478 0.611	0.451 0.570

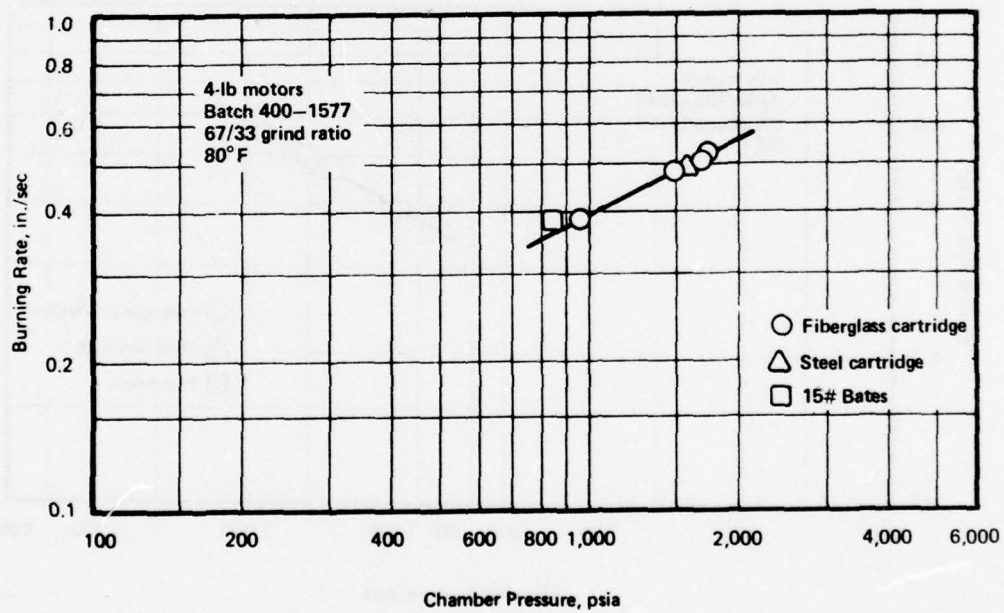
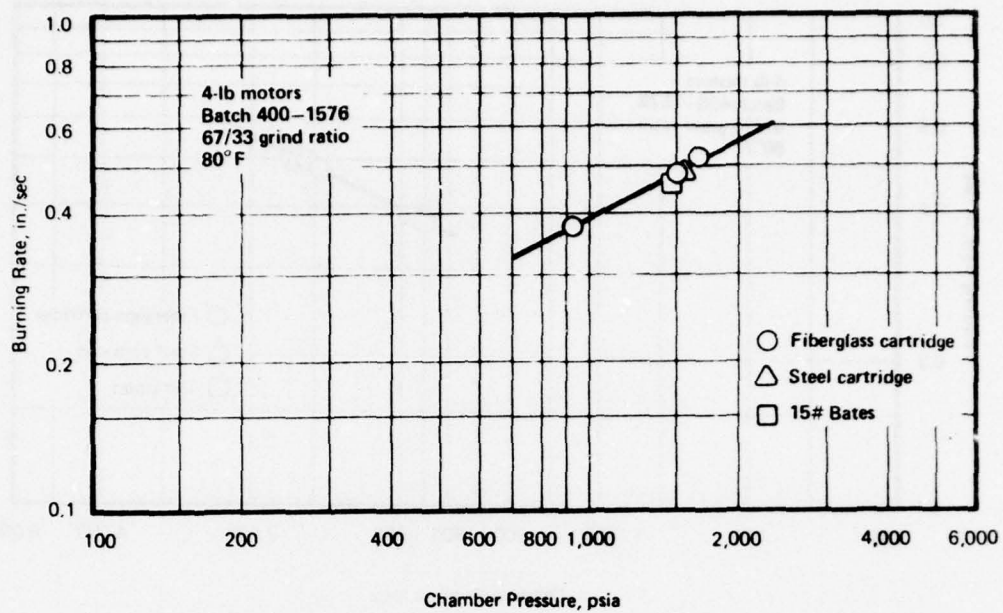
* Burn rate out of spec. Spec limits are:

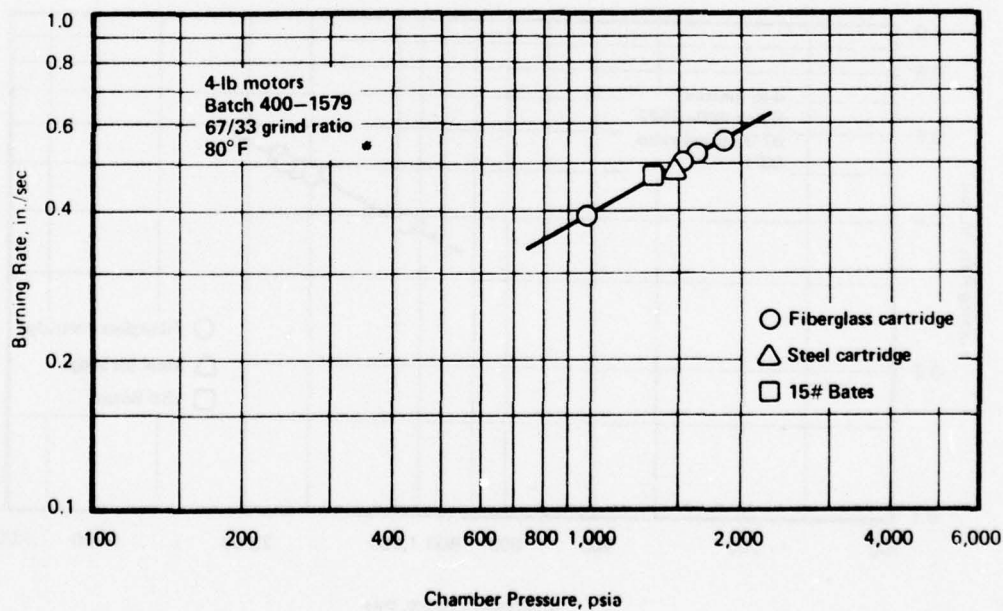
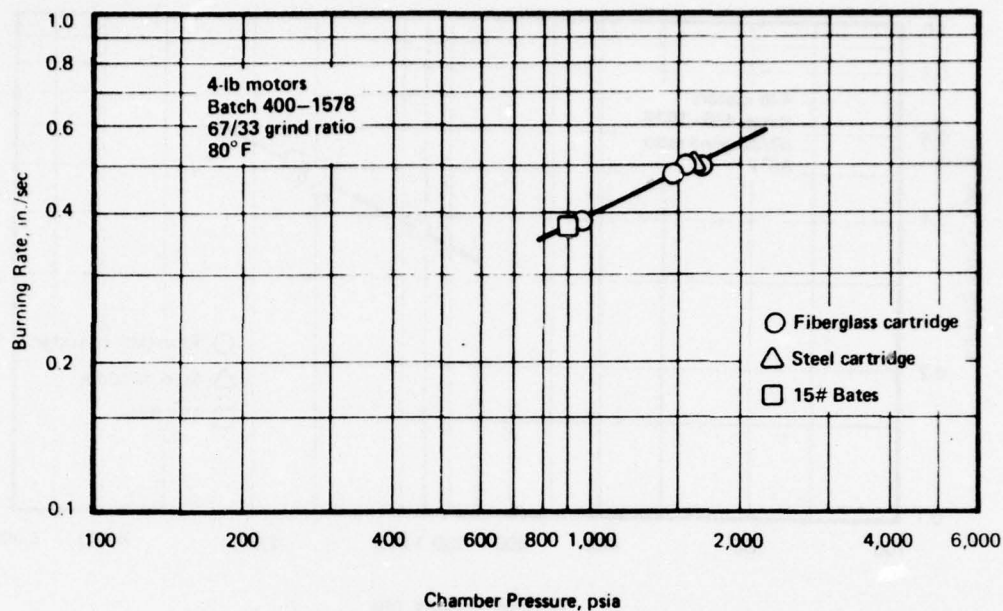
	Min	Max
Premix C @ 1400	0.605	0.646
Final @ 1400	0.570	0.617

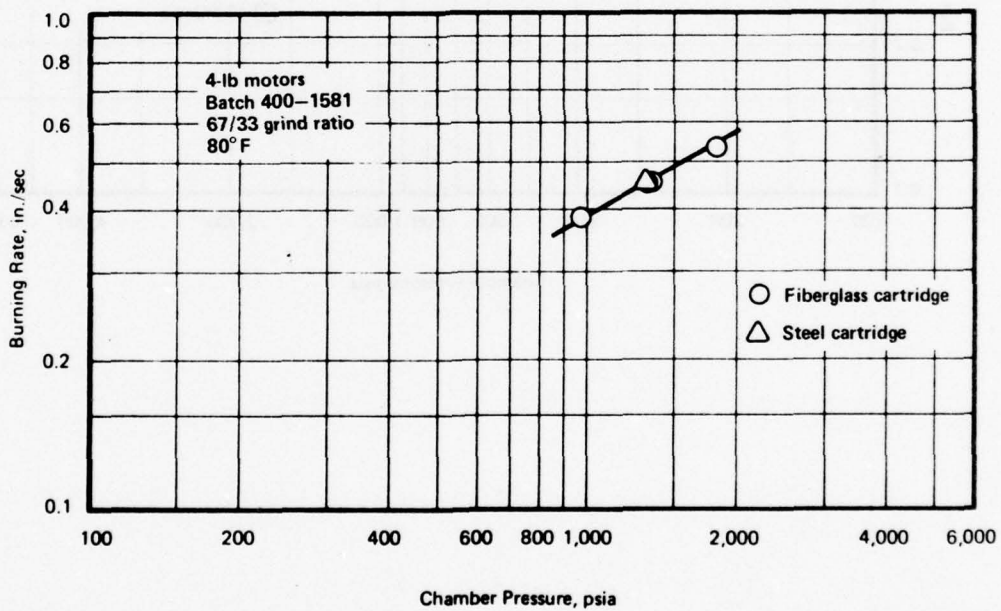
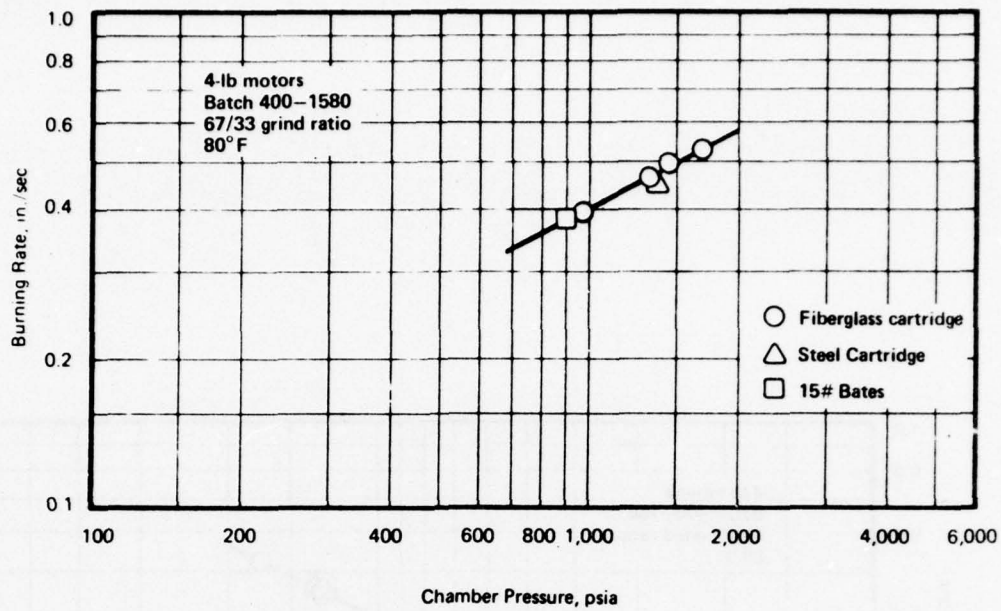
UTP-18, 803A QC PROCESSING AND PROPERTIES SUMMARY
PRODUCTION CASTING NO. 8

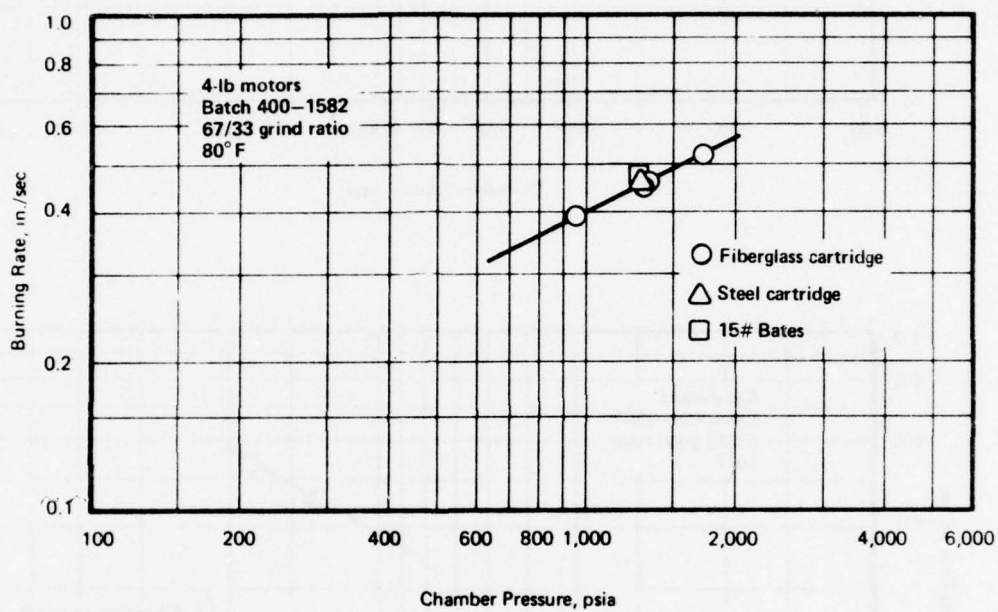
Parameter	1574	1575	1576	1577	1578	1579	1580	1581	1582	\bar{X}	Sx
400 Gallon Batch											
Grind ratio	67/33										
NCO/OH	0.81										
Fuel premix number	3500-8										
AP addition time, min	43	55	40	75	35	55	65	55	48		
Mix time after IPDI addition, sec	40	70	40	70	40	70	40	70	40		
IPDI @ (-min) after addition, wt %	.41 (70)	.37 (105)	.39 (84)	.35 (101)	.36 (81)	.34 (105)	.38 (65)	.36 (96)	.36 (81)	.369	.0022
Viscosity @ (-min) after IPDI addition, Kp @ 5000 dynes/cm ²	5.34 (60)	4.86 (100)	5.05 (84)	4.47 (102)	5.57 (81)	4.93 (105)	5.93 (60)	5.78 (96)	5.70 (81)	5.29	.0049
Max corrected stress @ 75°F, σ_{cm} , psi	117	120	116	113	113	119	125	120	111	117	4.4
Max corrected strain @ 75°F, ϵ_{cm} , %	34	39	42	34	36	35	41	39	38	37.6	2.96
True strain @ 75°F rupture, ϵ_r , %	35	39	44	35	36	35	42	40	38	38.2	3.31
Initial tangent modulus, E_o , psi	634	603	463	579	431	635	537	542	618	560	73.8











SECTION 2.13
 PRODUCTION RUN NO. 9
 (BATCHES 400-1588 THROUGH 400-1600)

PRODUCTION CASTING #9

UTP 18,803A 67/33 GRIND RATIO AND 0.81 NCO/OH RATIO

FOUR POUND MOTORS, 70°F

<u>Batch</u>	<u>Burning Rate, in/sec</u>			<u>Exponent</u>	<u>, %</u>
	<u>1000 psia</u>	<u>1400 psia</u>	<u>1700 psia</u>		
400-1588	.3948	.4815	.5400	.590	0.27
400-1589	.4046	.4825	.5340	.523	0.50
400-1590	.4035	.4882	.5434	.552	1.53
400-1591	.4078	.4903	.5453	.548	1.54
400-1592	.4046	.4877	.5432	.555	0.62
400-1593	.3993	.4894	.5503	.604	1.27
400-1594	.4036	.4834	.5364	.536	0.00
400-1595	.4084	.4892	.5428	.536	0.00
400-1596	.4073	.4895	.5443	.546	1.15
400-1597	.4123	.4924	.5455	.527	0.57
400-1598	.4125	.4960	.5517	.548	0.86
400-1599	.4132	.4967	.5523	.547	0.02
400-1600	.4134	.498	.5550	.555	0.62
Composite	.4063	.4898	.5456	.556	1.43

UTP 18,803A PRODUCTION CASTING #9
67/33 GRIND RATIO AND .81 NCO/OH RATIO
FOUR POUND MOTOR DATA 70°F

<u>Batch</u>	<u>Burning Rate/in/sec/Chamber Pressure, psia</u>
400-1588	.385/957, .525/1629, .5914/1976
400-1589	.3976/969, .5398/1718, .5527/1832
400-1590	.3700/798, .4107/1030, .5435/1650, .5654/1871
400-1591	.4048/990, .5821/1859, .5904/2017
400-1592	.3686/794, .4027/994, .5535/1737, .590/1992
400-1593	.3649/793, .4126/1064, .5567/1692, .6252/2133
400-1594	.361/776, .4181/1068, .5649/1873
400-1595	.3775/810, .4207/1057, .5459/1718
400-1596	.3848/837, .4258/1087, .5599/1751, 5641/1857
400-1597	.3885/835, .430/1084, .5557/1741, .5634/1826
400-1598	.3746/810, .4298/1074, .5392/1659, .5867/1877
400-1599	.380/820, .4159/1012, .5382/1622, .5859/1893
400-1600	.3832/831, .4173/1014, .5493/1689, .6049/1966

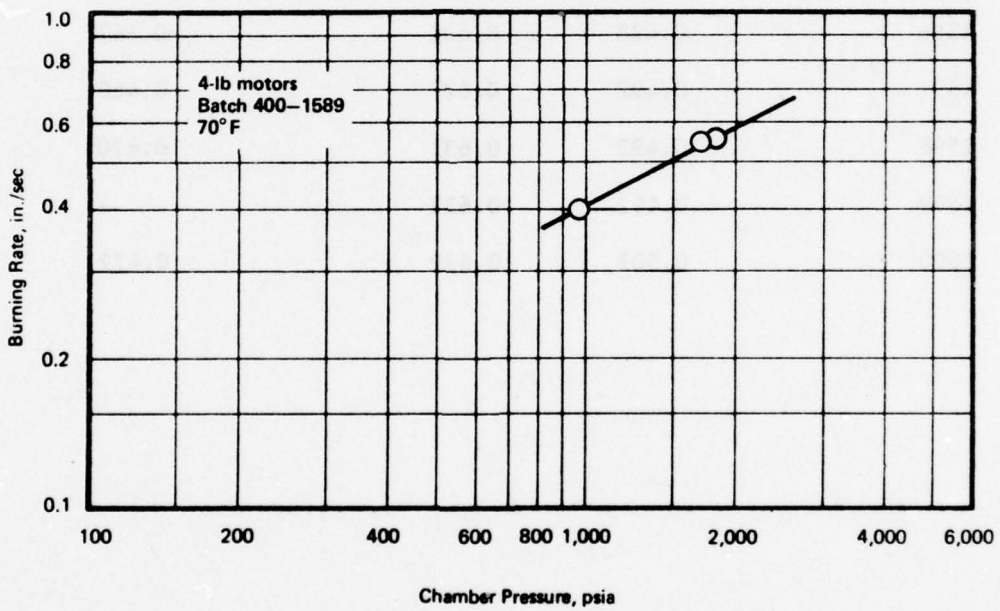
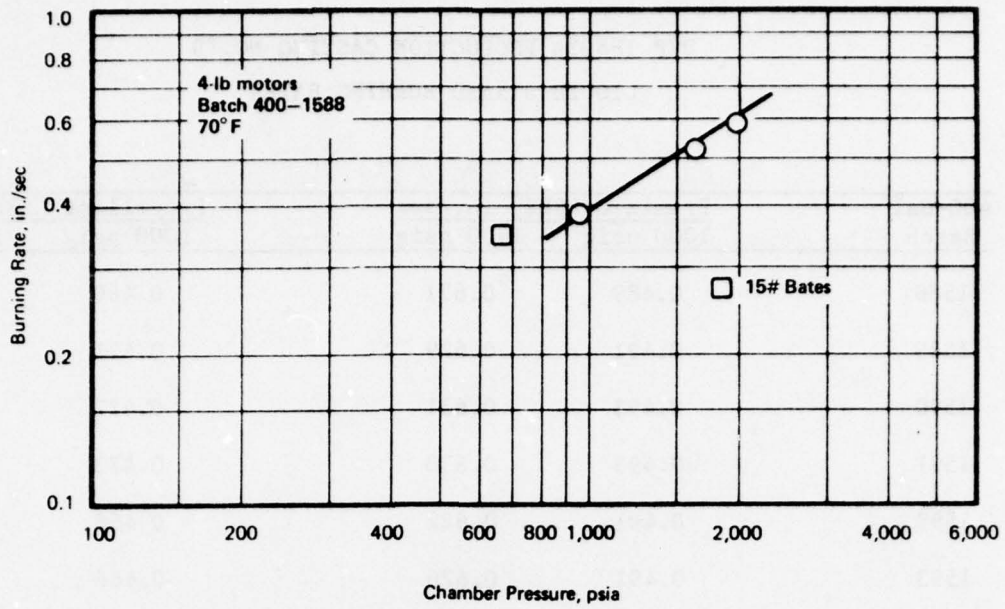
UTP-18,803A QC PROCESSING AND PROPERTIES SUMMARY
PRODUCTION CASTING NO. 9

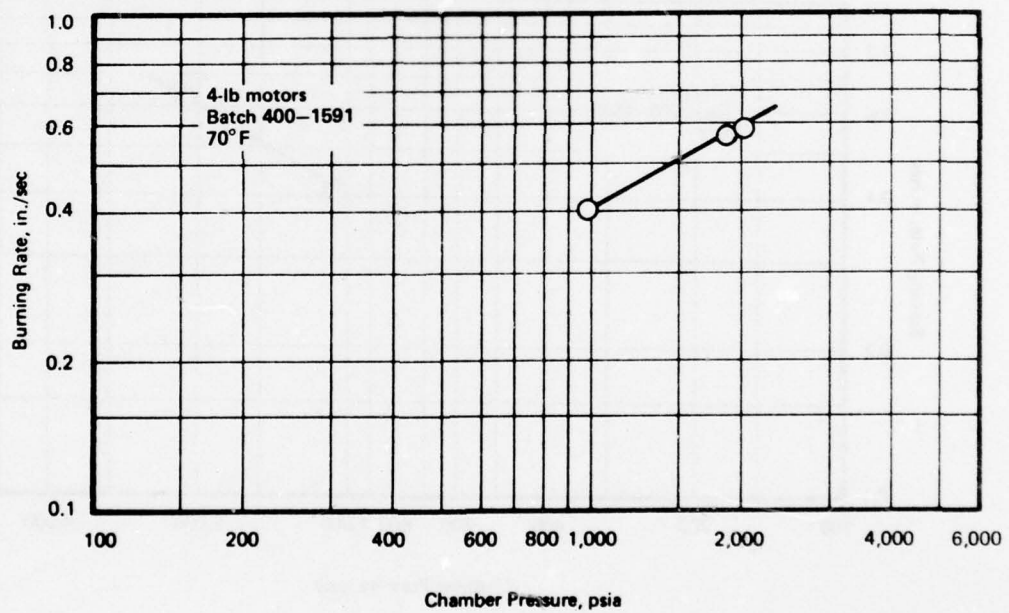
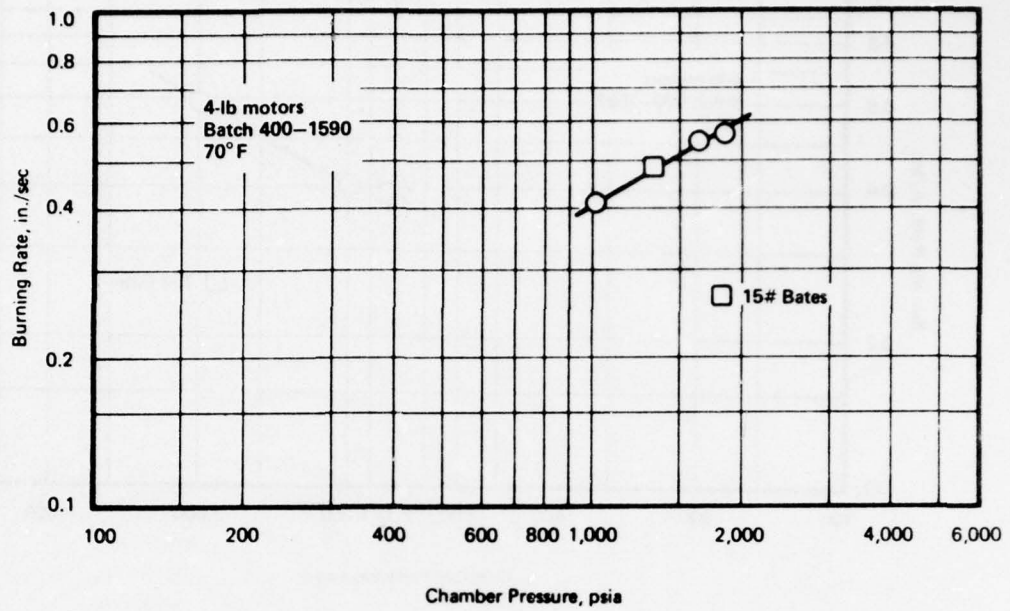
Parameter	400 Gallon Batch														\bar{X}	S_x	
	<u>1588</u>	<u>1589</u>	<u>1590</u>	<u>1591</u>	<u>1592</u>	<u>1593</u>	<u>1594</u>	<u>1595</u>	<u>1596</u>	<u>1597</u>	<u>1598</u>	<u>1599</u>	<u>1600</u>				
Grind ratio	67/33	→															
NCO/OH ratio	0.81	→															
Fuel Premix number	3500-8	→															
IPDI @ 60 min after addition, wt, %	0.40	0.40	0.38	0.38	0.38	0.38	0.40	0.38	0.38	0.40	0.38	0.39	0.40	0.388	0.0099		
Viscosity @ 60 min after IPDI addition, Kp @ 5000 dynes/cm ²	2.71	2.53	3.18	3.91	3.85	5.19	3.74	4.10	3.24	3.76	3.65	3.74	6.49	3.85	1.03		
Max corrected stress @ 75°F, σ^c_m , psi	97	102	101	99	97	92	101	97	98	90	113	116	109	100.9	7.6		
Max corrected strain @ 75°F ϵ^c_m , %	30	34	34	36	31	34	36	37	32	29	34	32	26	32.46	3.13		
True strain @ 75°F rupture, E_r , %	30	36	36	38	32	34	38	37	33	29	34	36	27	33.54	3.48		
Initial tangent modulus, E_o , psi	813	952	588	600	694	588	867	661	632	761	952	896	1005	770	153		

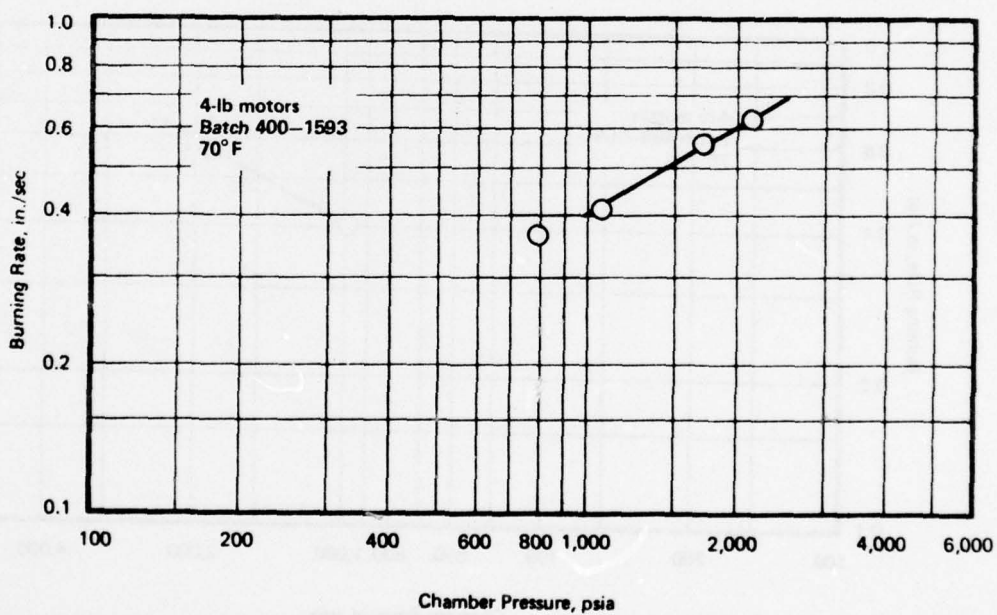
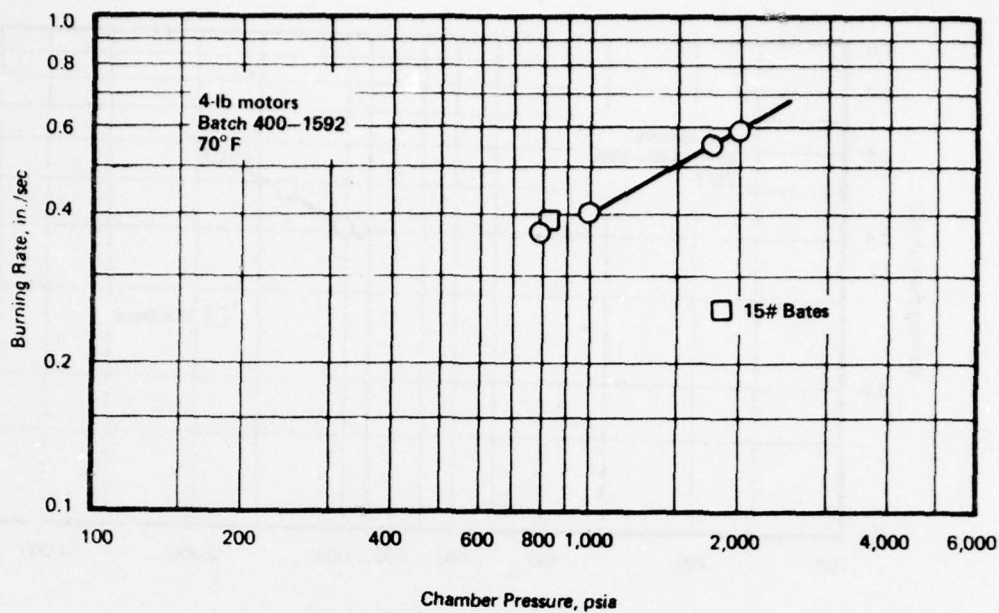
UTP 18803A PRODUCTION CASTING NO. 9

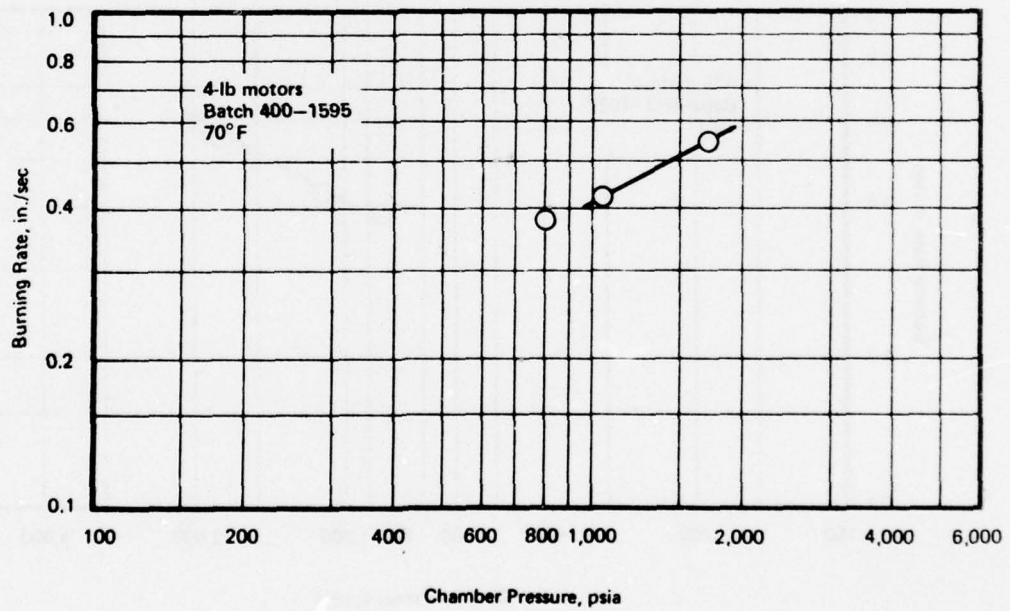
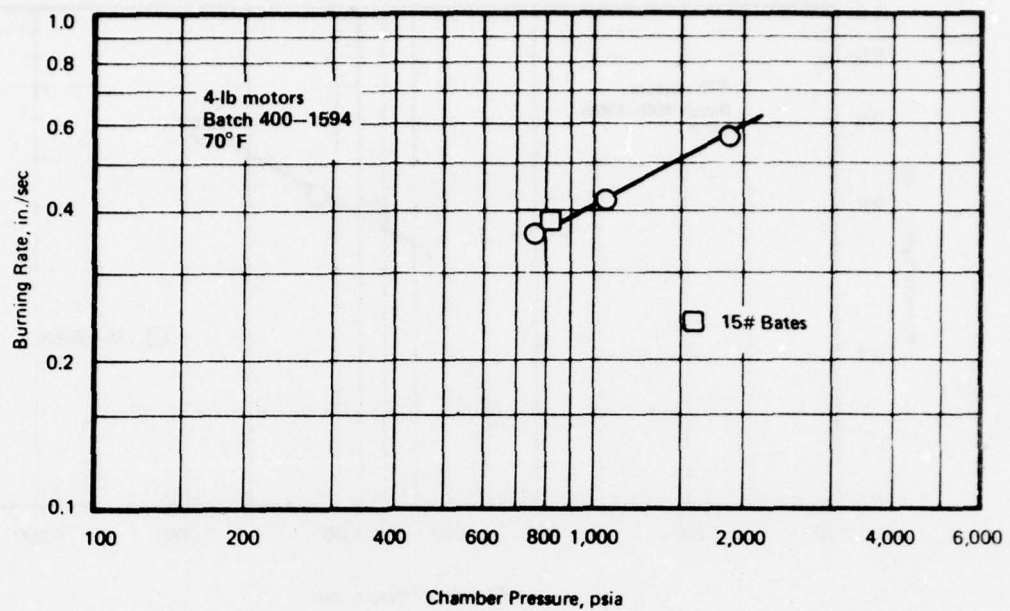
LIQUID STRAND BURNING RATES

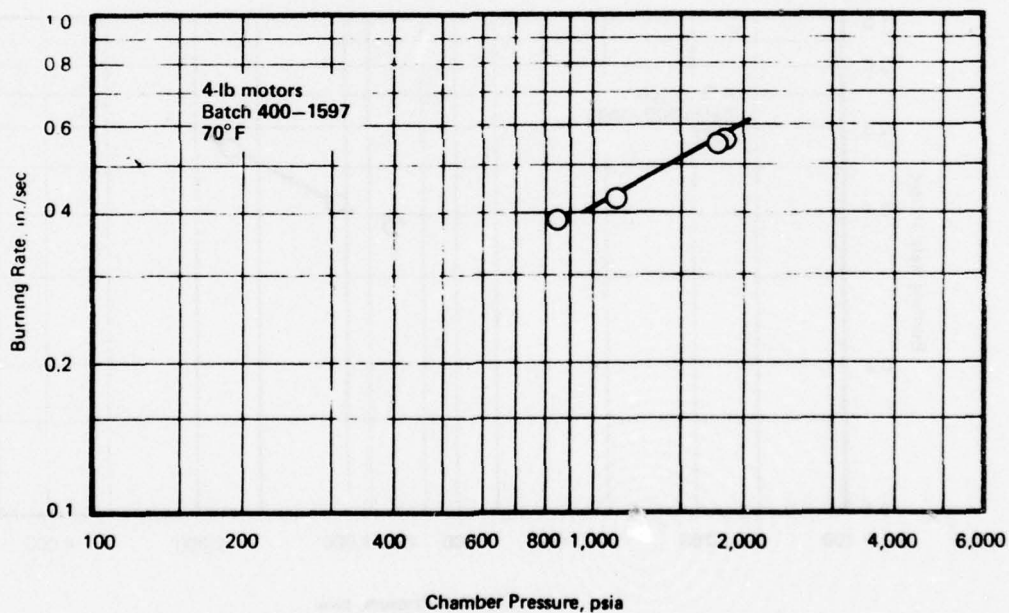
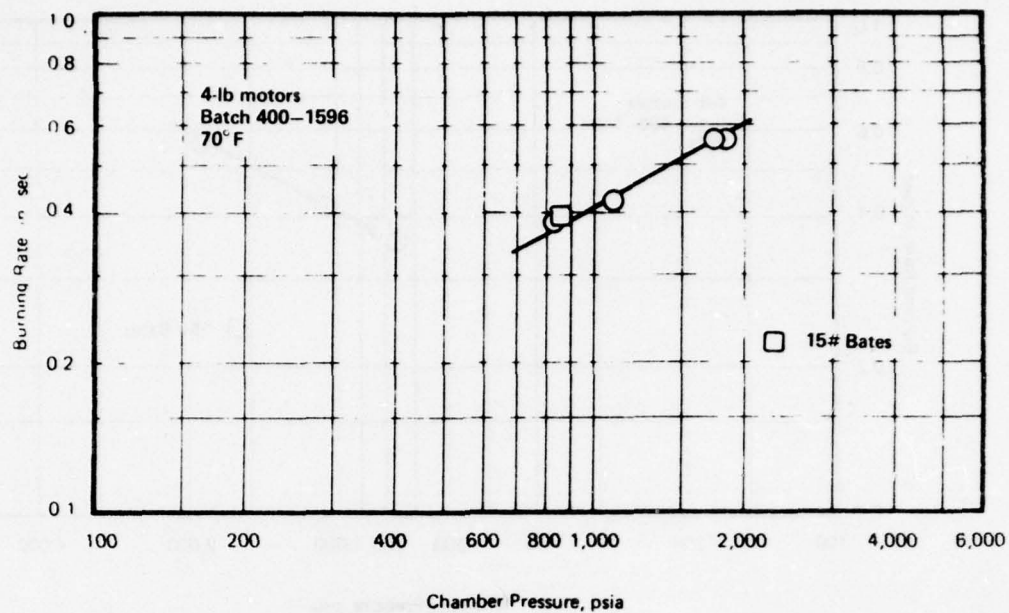
400-Gal Batch	<u>Premix C LSBR, in./sec</u>		<u>Propellant LSBR, in./sec</u>	
	1000 psig	1400 psig	1000 psig	1400 psig
1588	0.489	0.631	0.460	0.583
1589	0.491	0.629	0.471	0.600
1590	0.493	0.631	0.472	0.598
1591	0.493	0.630	0.473	0.598
1592	0.491	0.622	0.466	0.593
1593	0.491	0.626	0.466	0.589
1594	0.490	0.624	0.456	0.589
1595	0.478	0.613	0.469	0.594
1596	0.498	0.631	0.467	0.594
1597	0.492	0.627	0.468	0.598
1598	0.493	0.631	0.470	0.596
1599	0.492	0.632	-	0.599
1600	0.502	0.639	0.472	0.596

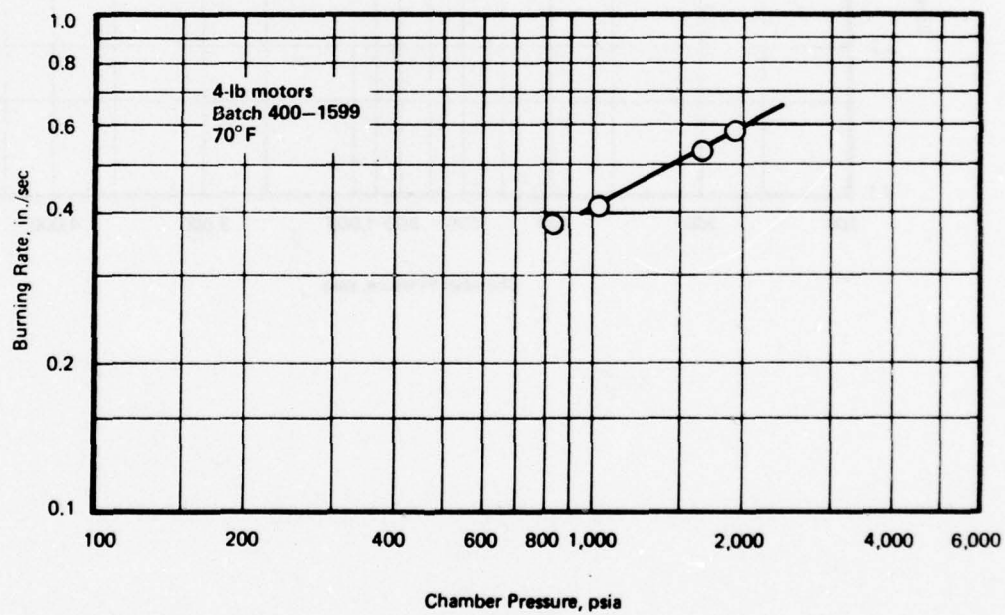
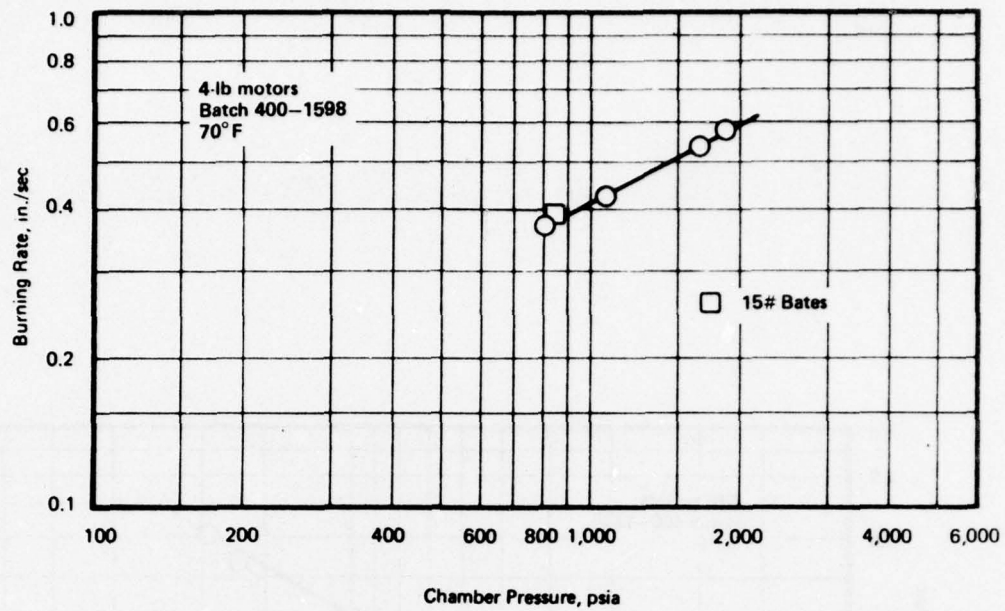


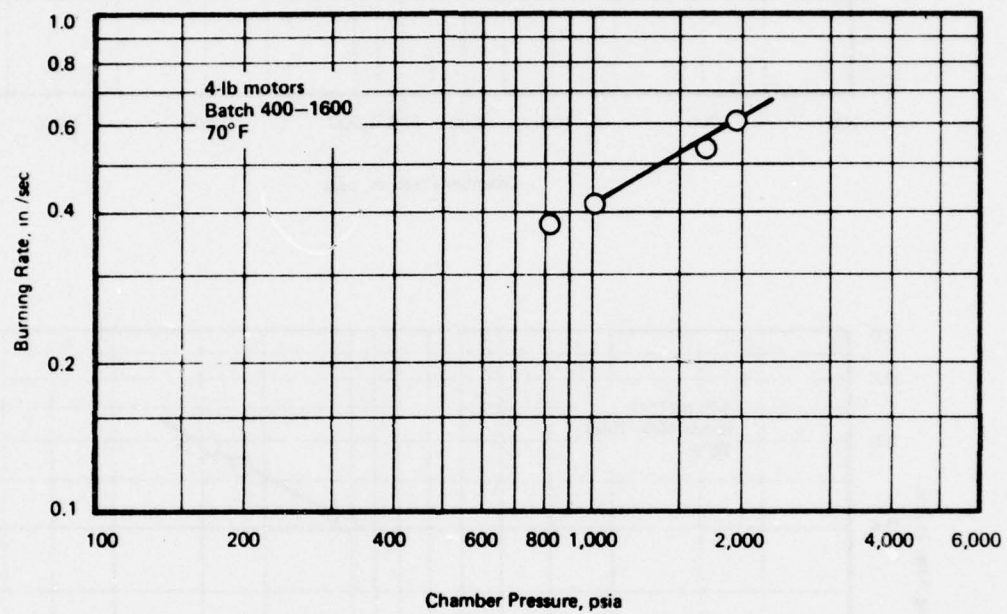












SECTION 2.14
 PRODUCTION RUN NO. 10
 (BATCHES 400-1606 THROUGH 400-1615)

PRODUCTION CASTING #10

FOUR POUND MOTORS

62°F

<u>Batch</u>	<u>Grind Ratio</u>	<u>Burning Rate, in/sec</u>			<u>Exponent</u>	<u>Standard Deviation Sx, %</u>
		<u>1000 psia</u>	<u>1400 psia</u>	<u>1700 psia</u>		
400-1606	65/35	.403	.481	.533	.528	.2
400-1607	68/32	.399	.459	.497	.412	.8
400-1608	66/34	.395	.472	.523	.530	.8
400-1609	66/34	.394	.467	.515	.504	.8
400-1610	66/34	.411	.481	.527	.466	.6
400-1611	66/34	.404	.475	.522	.483	1.1
400-1612	66/34	.401	.480	.532	.532	.2
400-1613	66/34	.402	.475	.523	.495	.7
400-1614	66/34	.406	.489	.545	.554	0.1
400-1615	66/34	.402	.469	.513	.459	0.0
Composite of 66/34 Batches	66/34	.400	.477	.528	.522	1.4

UTP 18803A PRODUCTION CASTING NO. 10

FOUR POUND MOTOR DATA 62°F

<u>Batch</u>	<u>Burning Rate, in/sec/Chamber Pressure, psia</u>
400-1606	.3786/849, .4220/1088, .4459/1217, .5085/1551
400-1607	.3693/812, .3993/1012, .4306/1176, .4573/1404
400-1608	.382/887, .3938/986, .4262/1176, .4817/1444
400-1609	.3679/840, .3826/949, .4376/1207, .4670/1415
400-1610	.3706/810, .3887/878, .4606/1263, .487/1452
400-1611	.3637/789, .3955/944, .4266/1151, .4839/1435
400-1612	.3952/921, .3858/931, .4767/1380, .5156/1608
400-1613	.3739/859, .3963/843, .4586/1323, .4905/1472
400-1614	.3782/821, .3881/920, .4567/1238, .4995/1450
400-1615	.3722/804, .4113/1053, .4414/1227, .4680/1395

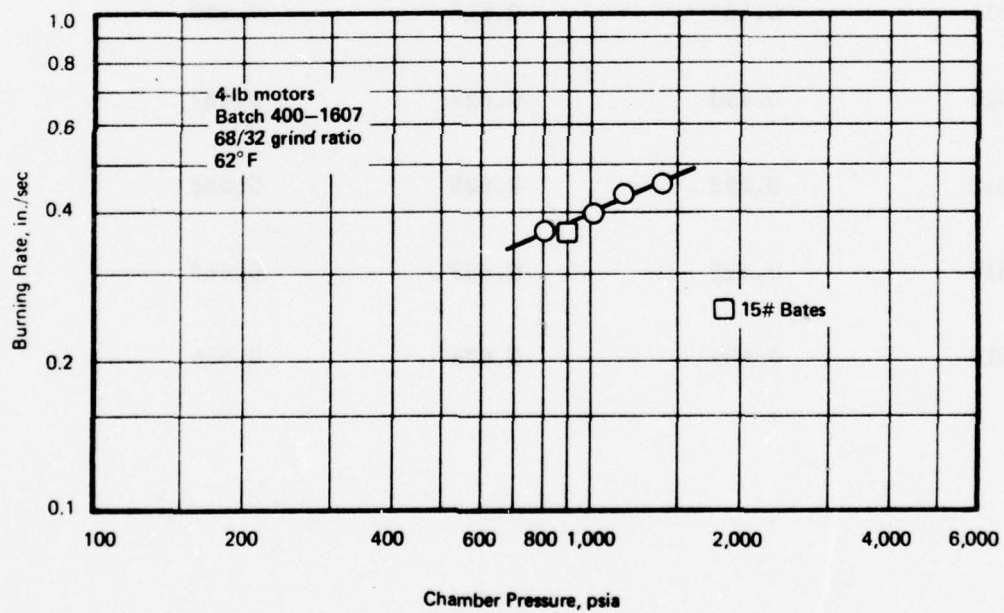
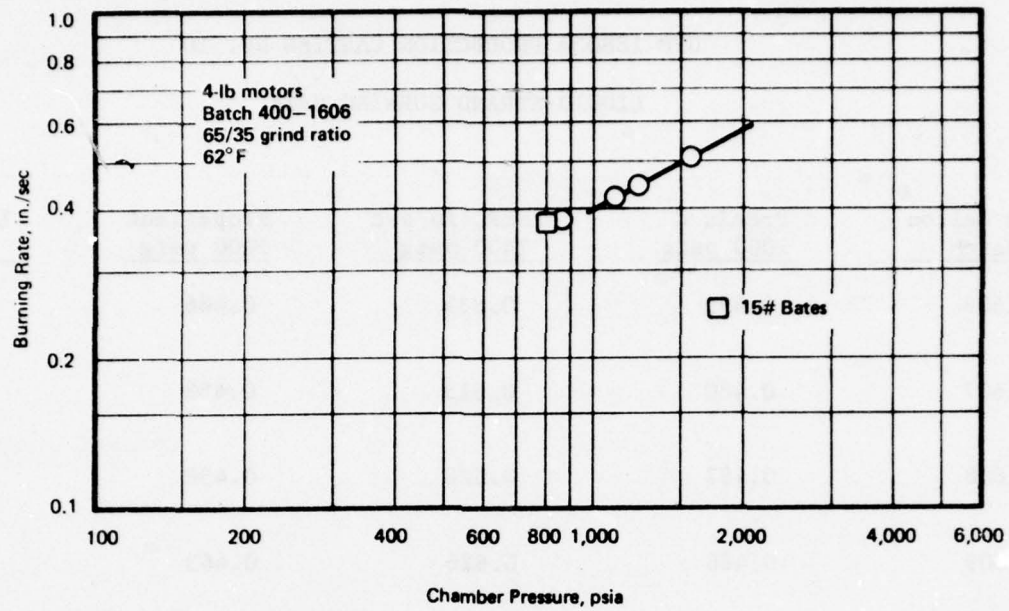
UTP-18,803A QC PROCESS AND PROPERTIES SUMMARY
PRODUCTION CASTING, 400-GALLON BATCH

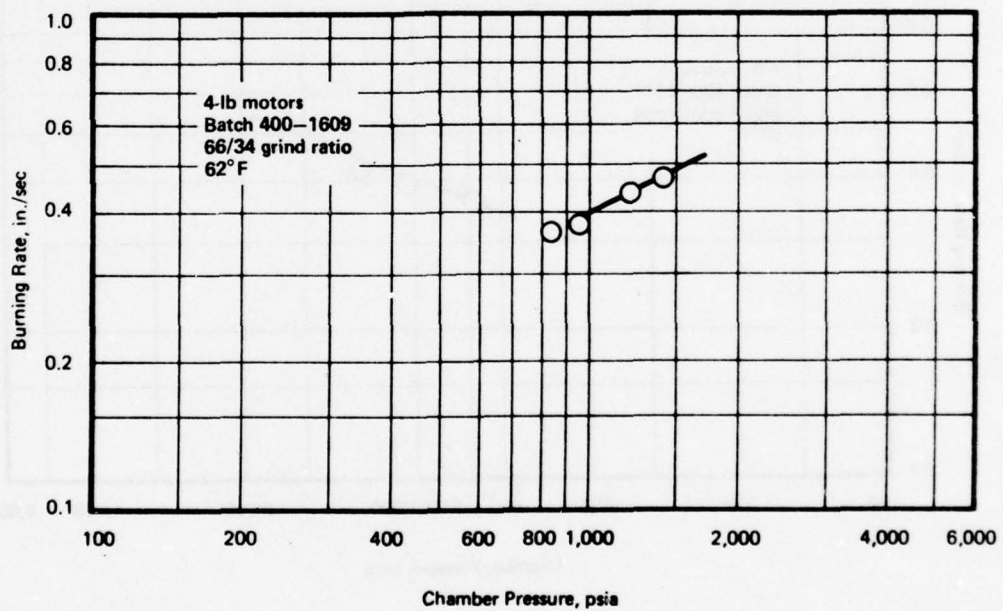
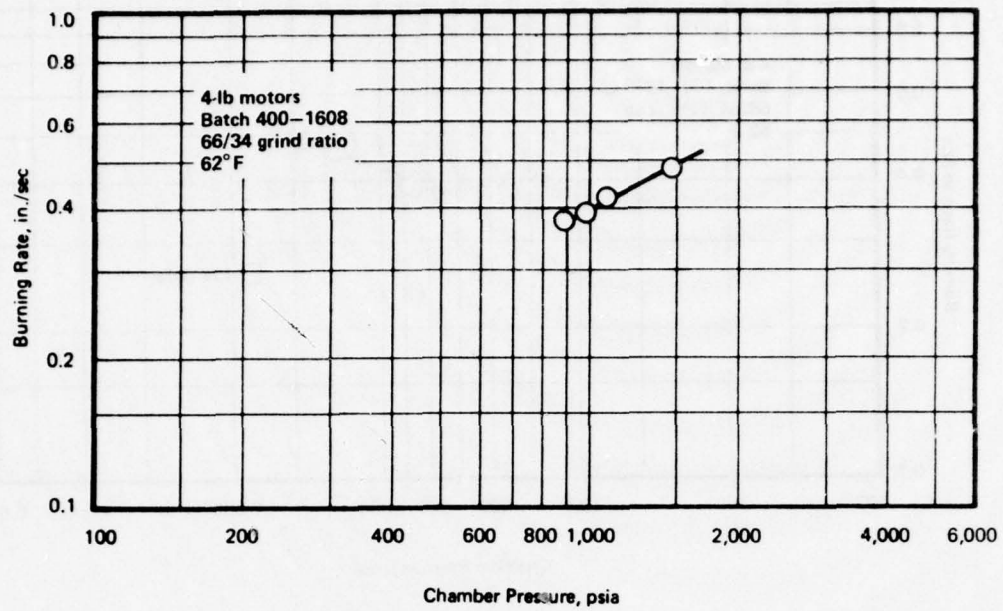
Parameter	1606	1607	1608	1609	1610	1611	1612	1613	1614	1615	\bar{X}	S_x
Grind ratio	65/35	68/32	66/34	66/34	66/34	66/34	66/34	66/34	66/34	66/34		
NCO/OH ratio	0.81	0.81	0.81	0.81	0.81	0.81	0.81	0.81	0.81	0.81		
Fuel premix number	3500.9	3500.9	3500.9	3500.9	3500.9	3500.9	3500.9	3500.9	3500.9	3500.9		
IPDI @ 60 min after addition, %	0.38	0.37	0.38	0.36	0.36	0.38	0.36	0.36	0.36	0.36	0.367	0.0095
Viscosity @ 60 min after IPDI addition, Kp @ 5000 ues/cm ²	5.48	5.14	5.16	5.77	5.10	5.74	6.08	6.89	6.28	6.81	5.845	0.66
Max corrected stress @ 75°F, σ_c , psia	114	118	112	100	107	99	102	112	114	113	109.1	6.66
Max corrected strain @ 75°F, ϵ_c , %	42	38	37	36	40	33	38	38	34	39	37.5	2.68
True strain @ 75°F rupture, E_r , %	44	39	38	38	41	34	39	38	36	40	38.7	2.71
Initial tangent modulus, E_o , psi	746	966	884	706	805	838	828	866	1015	985	863.9	101.4

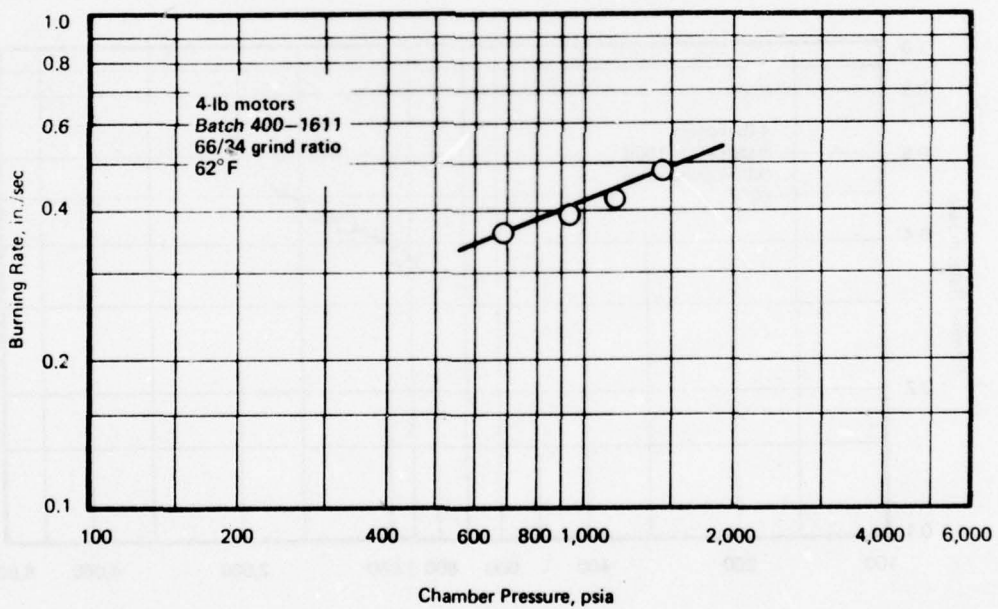
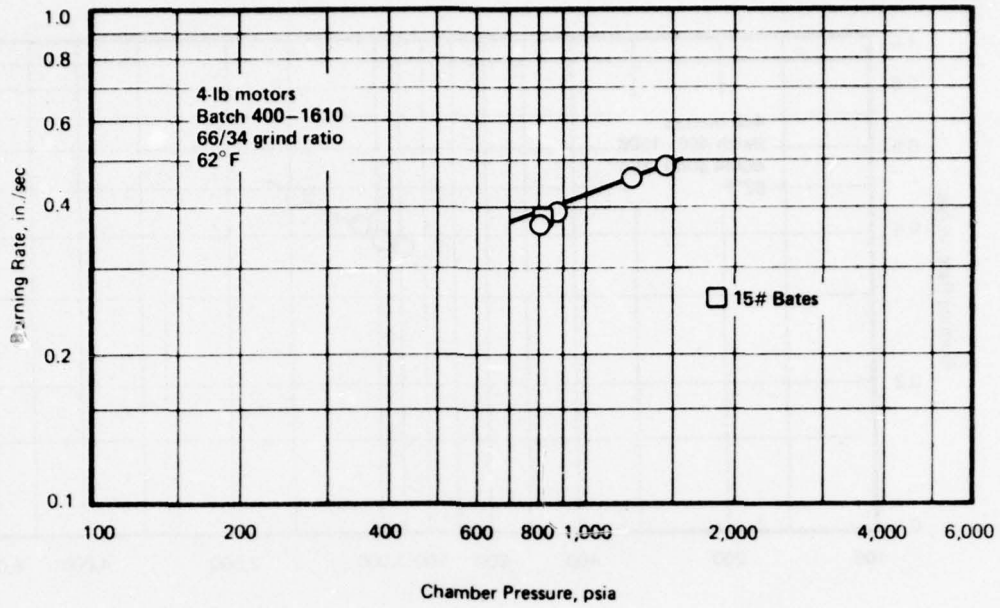
UTP 18803A PRODUCTION CASTING NO. 10

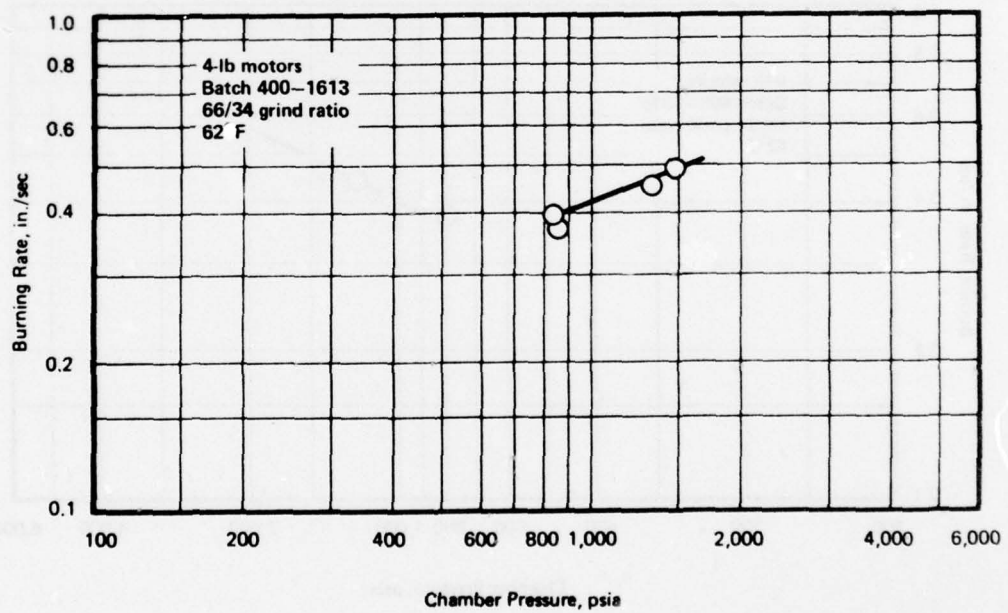
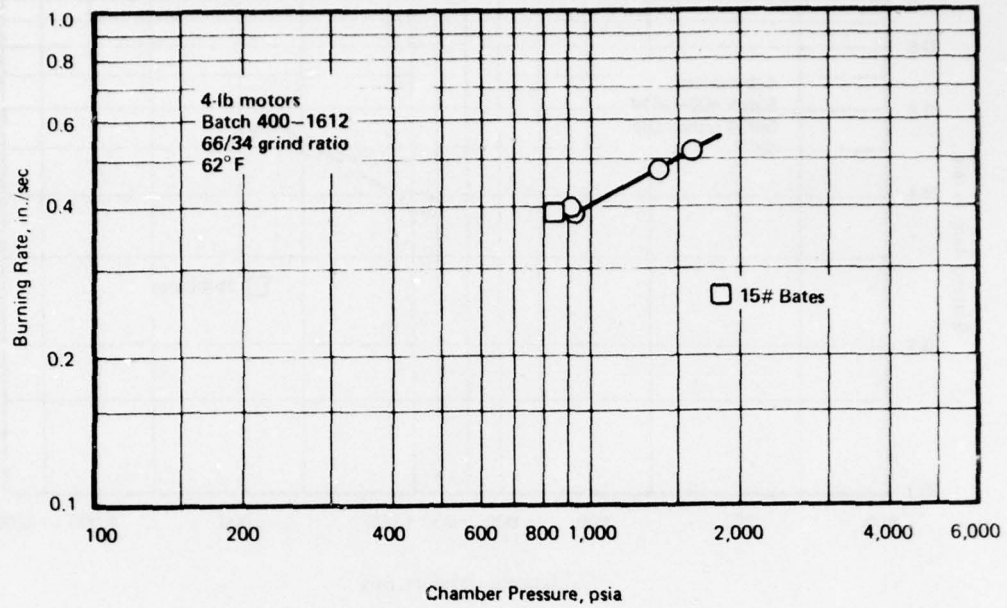
LIQUID STRAND BURNING RATE

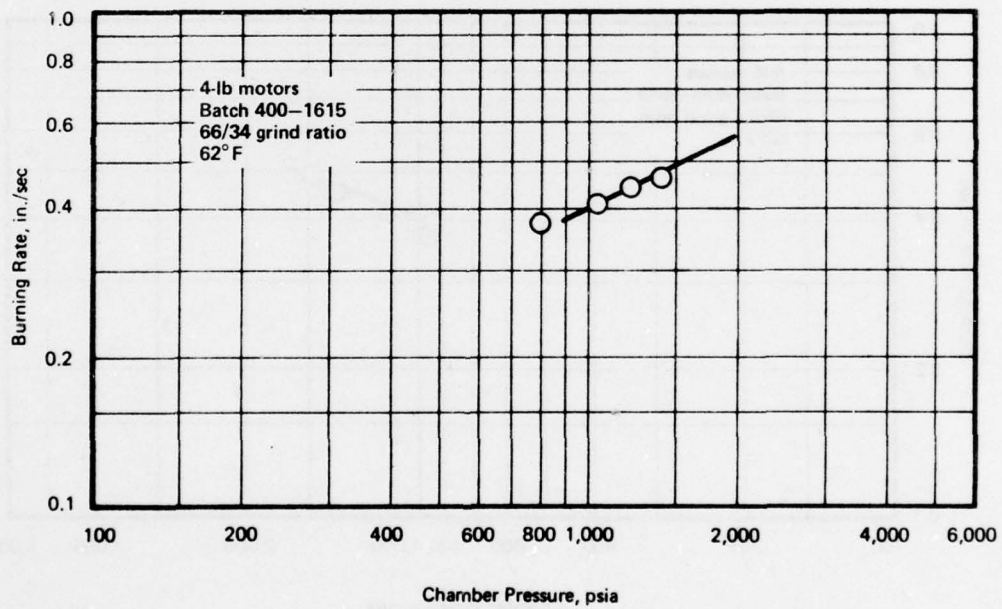
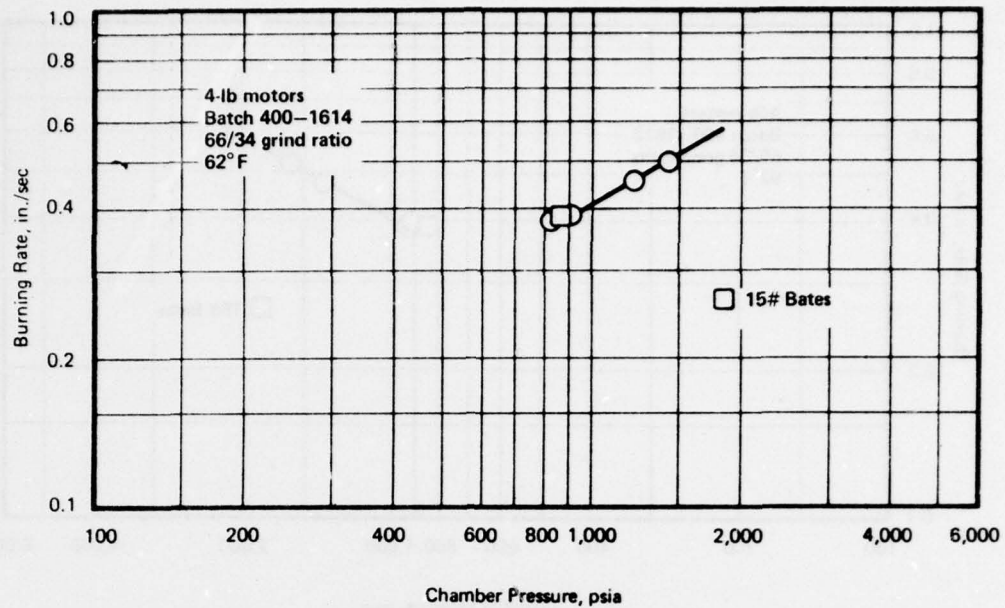
<u>400 Gallon Batch</u>	<u>Premix C 1000 psig</u>	<u>LSBR, in/sec 1400 psig</u>	<u>Propellant 1000 psig</u>	<u>LSBR, in/sec 1400 psig</u>
1606	0.495	0.635	0.466	0.600
1607	0.480	0.613	0.458	0.581
1608	0.487	0.628	0.458	0.589
1609	0.486	0.626	0.463	0.590
1610	0.487	0.625	0.460	0.582
1611	0.487	0.616	0.459	0.582
1612	0.490	0.627	0.467	0.591
1613	0.493	0.625	0.466	0.596
1614	0.495	0.633	0.466	0.593
1615	0.489	0.626	0.466	0.592











SECTION 2.15
PRODUCTION RUN NO. 11
(BATCHES 400-1620 THROUGH 400-1629)

PRODUCTION CASTING #11

FOUR POUND MOTORS

68 F

400 Gallon Batch	Grind Ratio	Burning Rate, in/sec			Exponent	Standard Deviation, Sx, %
		1000 psia	1400 psia	1700 psia		
1620	65/35	.407	.480	.527	.487	0.4
1621	66/34	.397	.477	.531	.548	1.1
1622	66/34	.403	.472	.517	.469	.5
1623	66/34	.392	.469	.520	.531	.5
1624	66/34	.396	.463	.507	.467	.5
1625	66/34	.398	.481	.537	.564	.6
1626	66/34	.396	.466	.512	.482	--
1627	66/34	.397	.474	.525	.526	1.2
1628	66/34	.404	.478	.527	.499	.6
1629	66/34	.407	.486	.538	.523	0.4
Composite		.400	.474	.524	.510	1.53

UTP 18803A PRODUCTION CASTING NO. 11

FOUR POUND MOTOR DATA 68 F

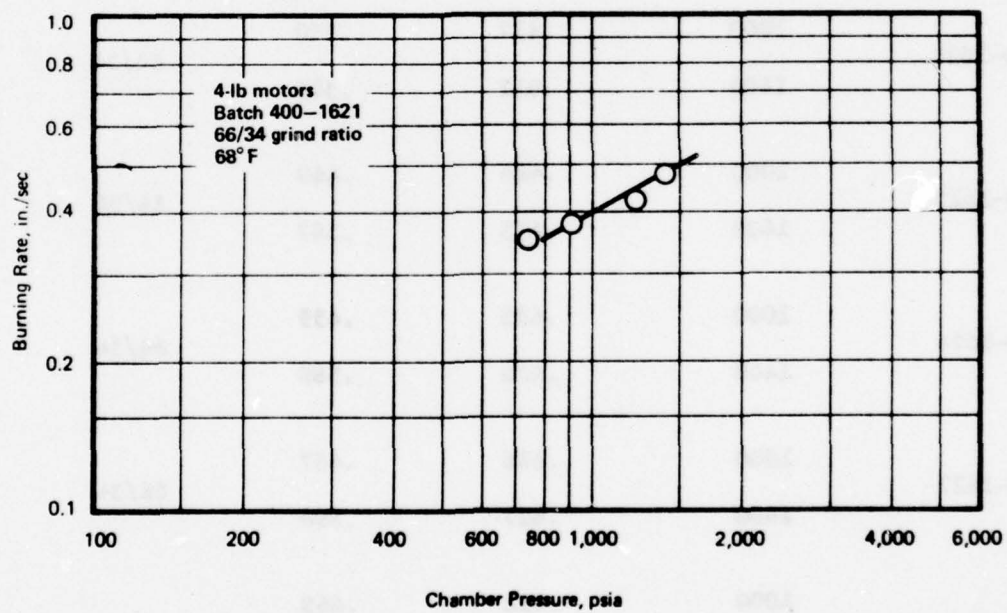
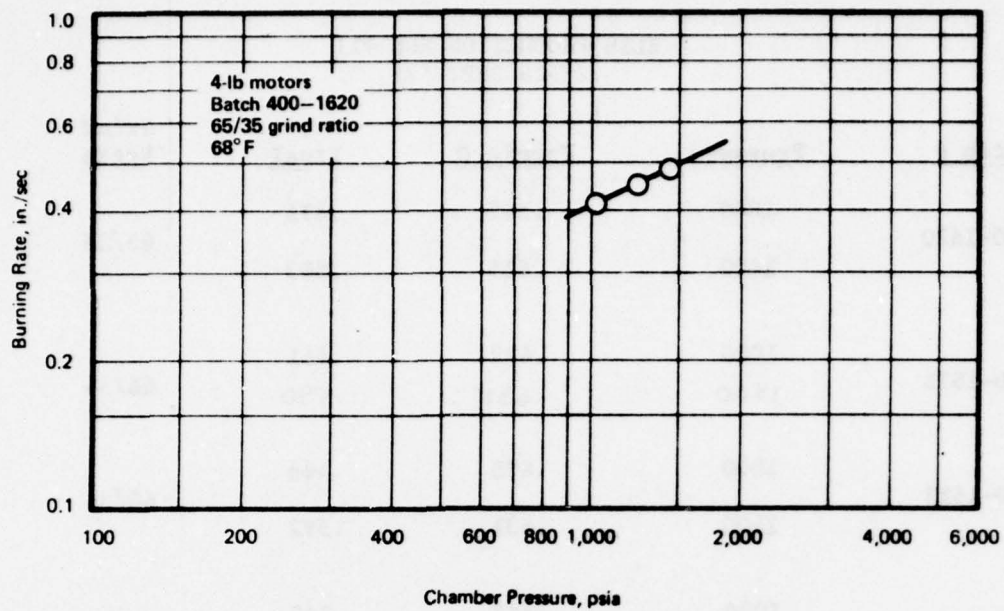
<u>Batch</u>	<u>Burning Rate, in/sec/Chamber Pressure, psia</u>
400-1621	.3507/753, .3792/913, .4357/1212, .4837/1414
400-1622	.3592/765, .3878/925, .4552/1283, .4835/1486
400-1623	.3462/755, .3805/955, .4393/1212, .4887/1530
400-1624	.3503/746, .3888/958, .4273/1194, .4635/1393
400-1625	.3591/777, .3900/961, .4491/1253, .4880/1424
400-1626	.3656/783, .3844/937, .4261/1200, .4444/1266
400-1627	.3566/773, .3900/959, .4352/1222, .4836/1431
400-1628	.3681/787, .3953/962, .4502/1225, .4809/1429
400-1629	.395/951, .413/1027, .416/1029, .503/1499
400-1620	.4133/1031, .4523/1244, .488/1450

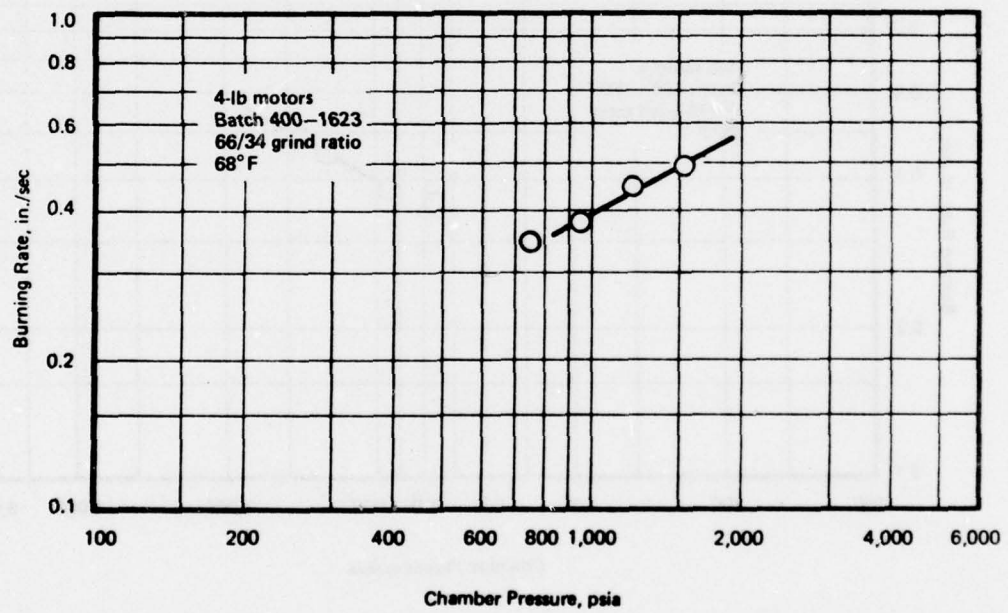
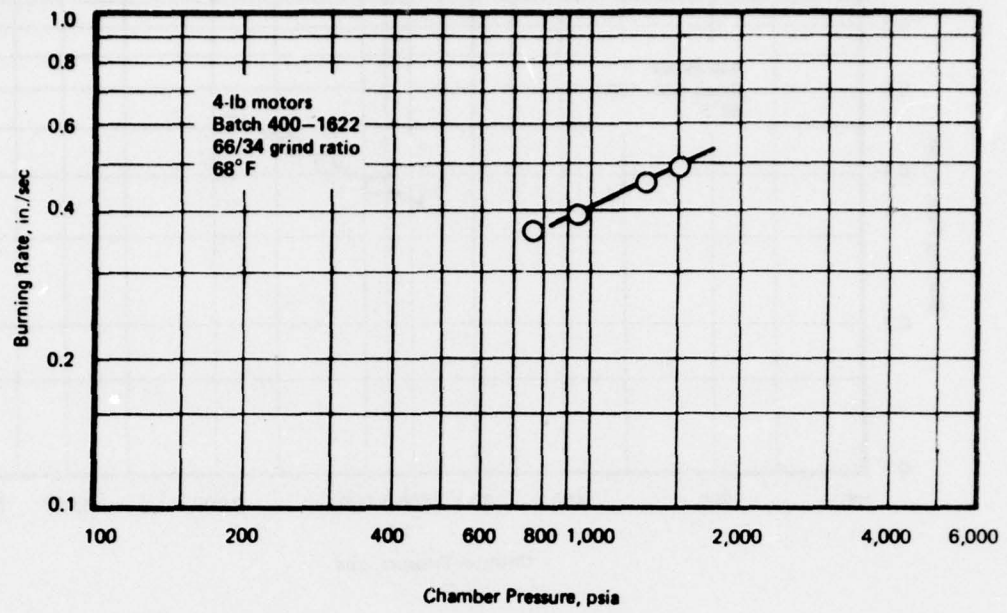
UTP-18,803A QC PROCESSING AND PROPERTIES SUMMARY
PRODUCTION CASTING NO. 11

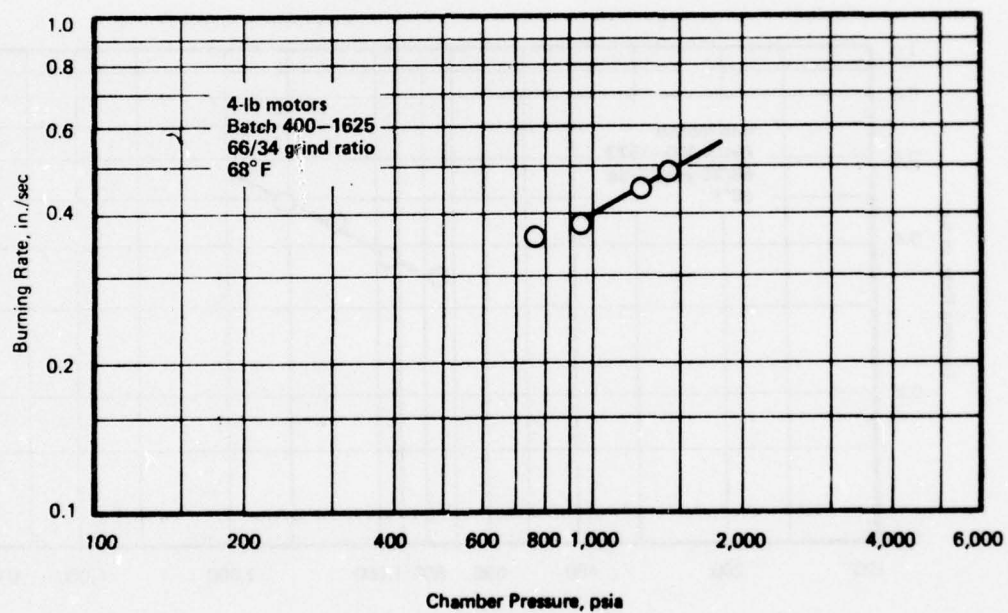
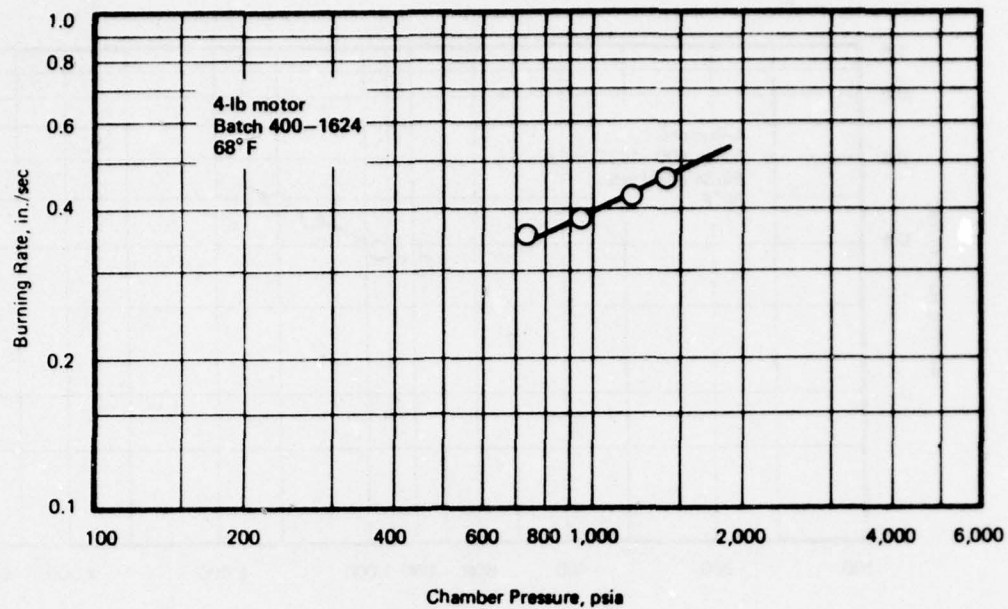
Parameter	1620	1621	1622	1623	1624	400 Gallon Batch				\bar{X}	S_x
						1625	1626	1627	1628		
Grind ratio	65/35	66/34	66/34	66/34	66/34	66/34	66/34	66/34	66/34	66/34	
NCO/OH ratio	0.81	0.81	0.81	0.81	0.81	0.81	0.81	0.81	0.81	0.81	
Fuel premix number	3500-10	3500-10	3500-10	3500-10	3500-10	3500-10	3500-10	3500-10	3500-10	3500-10	
IPDI @ 60 min after addition, wt %	0.36	0.34	0.37	0.36	0.34	0.34	0.36	0.36	0.37	0.36	.0117
Viscosity @ 60 min after IPDI addition, Kp @ 5000 dynes/cm ²	6.04	6.35	6.36	5.85	7.26	5.86	5.77	5.75	6.71	5.91	0.49
Max corrected stress @ 75°F, σ_{cm} , psi	127	127	126	110	113	106	124	123	128	133	8.9
Max corrected strain @ 75°F, ϵ_{cm} , %	38	34	34	32	36	31	36	36	37	34	2.2
True strain @ 75°F rupture, ϵ_r , %	38	35	35	34	39	31	31	37	37	36	2.3
Initial tangent modulus, E_o , psi	1062	1100	1104	806	810	952	1010	916	816	988	117

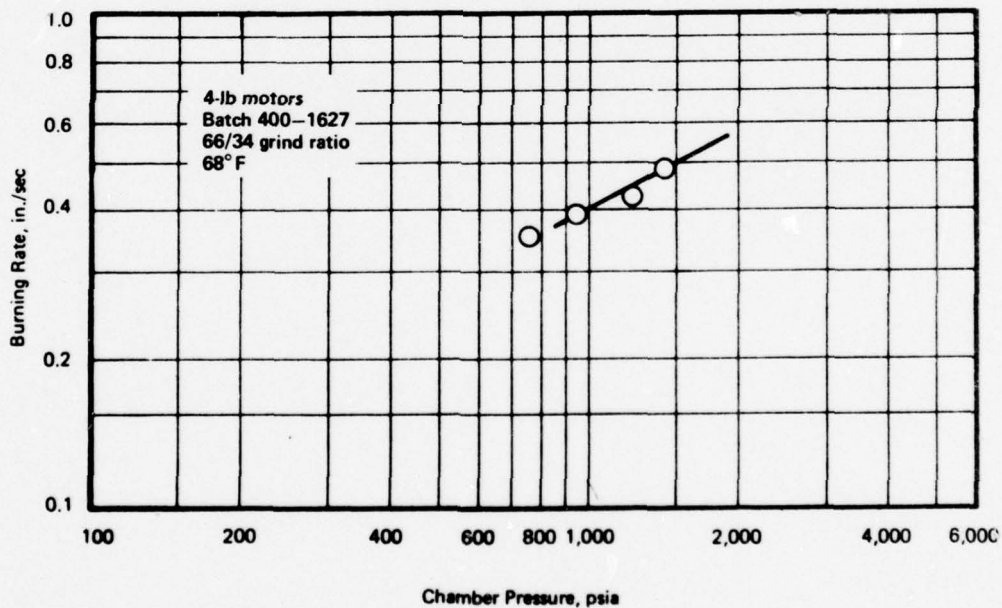
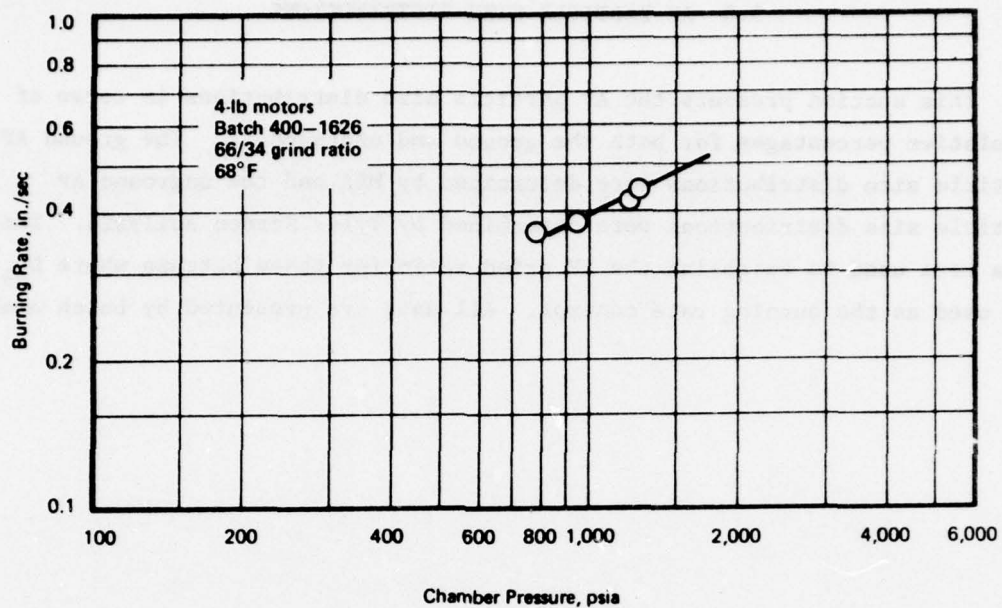
ELSH PRODUCTION RUN #11
28-29 SEPT '77

<u>Batch #</u>	<u>Pressure</u>	<u>Premix C</u>	<u>Final</u>	<u>Grind Ratio</u>	<u>Curative Ratio</u>
400-1620	1000	.502	.471	65/35	0.81
	1400	.635	.603		
400-1621	1000	.492	.461	66/34	0.81
	1400	.635	.590		
400-1622	1000	.495	.466	66/34	0.81
	1400	.631	.592		
400-1623	1000	.487	.462	66/34	0.81
	1400	.628	.588		
400-1624	1000	.477	.460	66/34	0.81
	1400	.612	.585		
400-1625	1000	.484	.460	66/34	0.81
	1400	.623	.587		
400-1626	1000	.483	.459	66/34	0.81
	1400	.620	.589		
400-1627	1000	.486	.467	66/34	0.81
	1400	.627	.590		
400-1628	1000	.492	.469	66/34	0.81
	1400	.633	.596		
400-1629	1000	.490	.462	66/34	0.81
	1400	.625	.594		





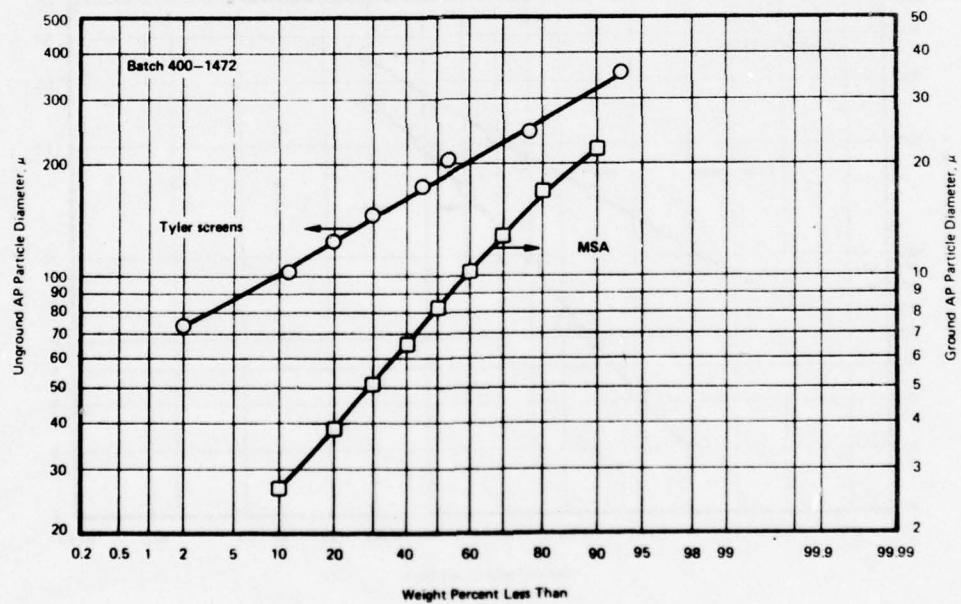
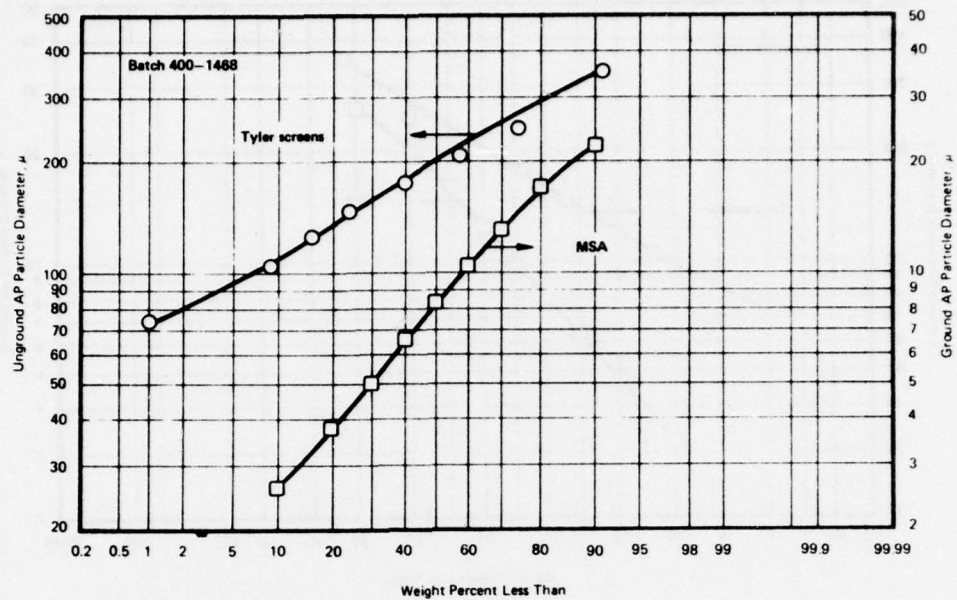


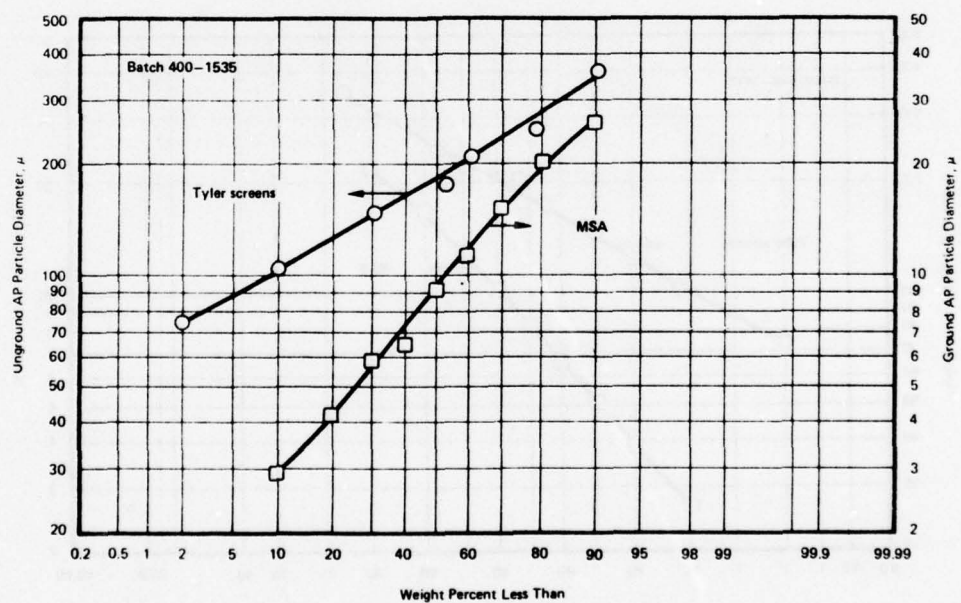
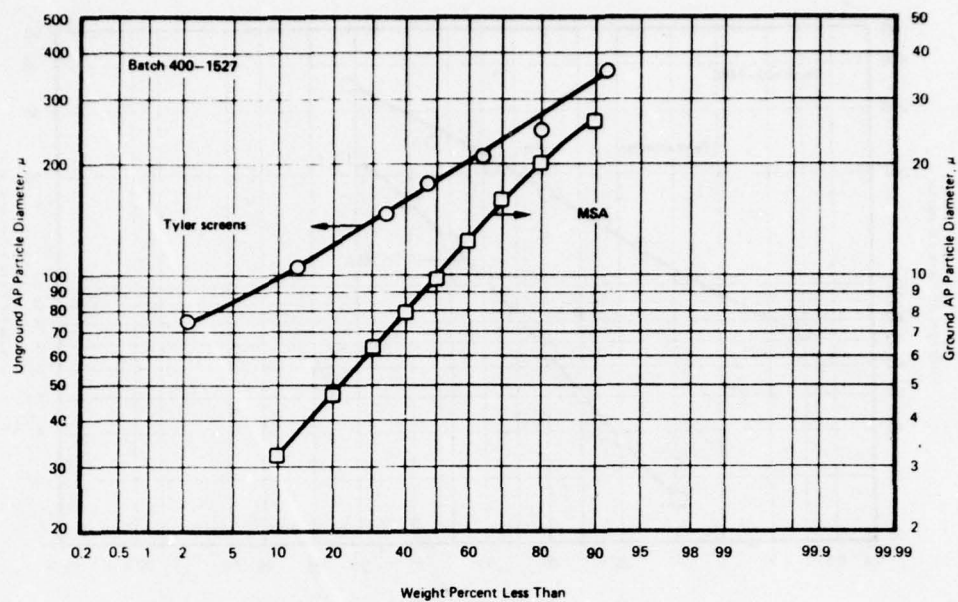


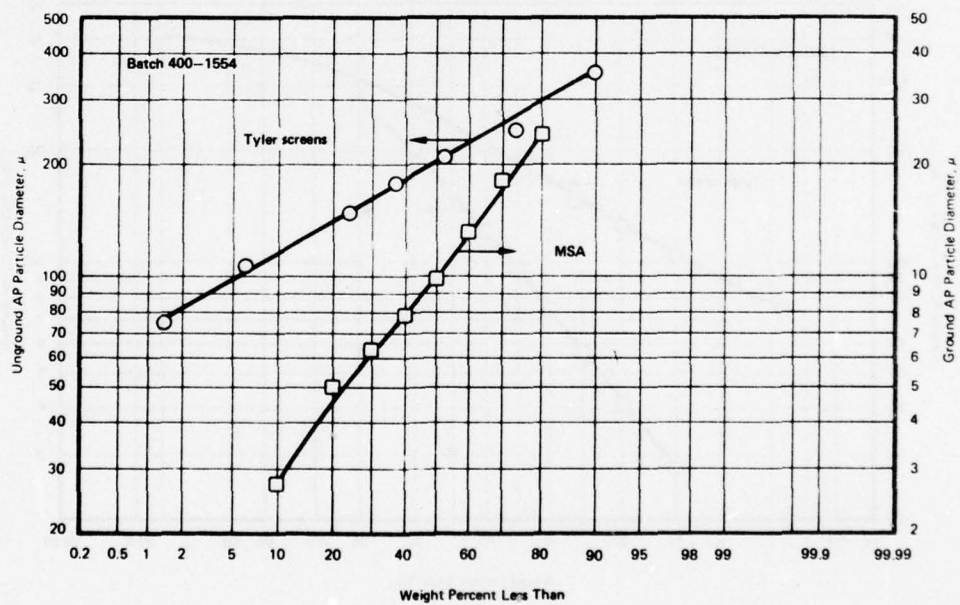
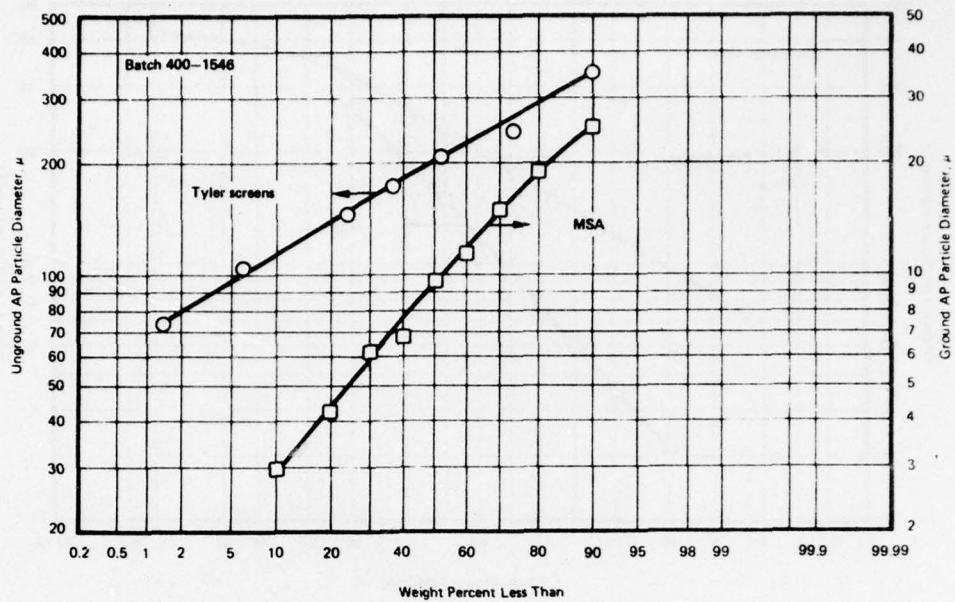
3.0 AP PARTICLE SIZE DISTRIBUTIONS

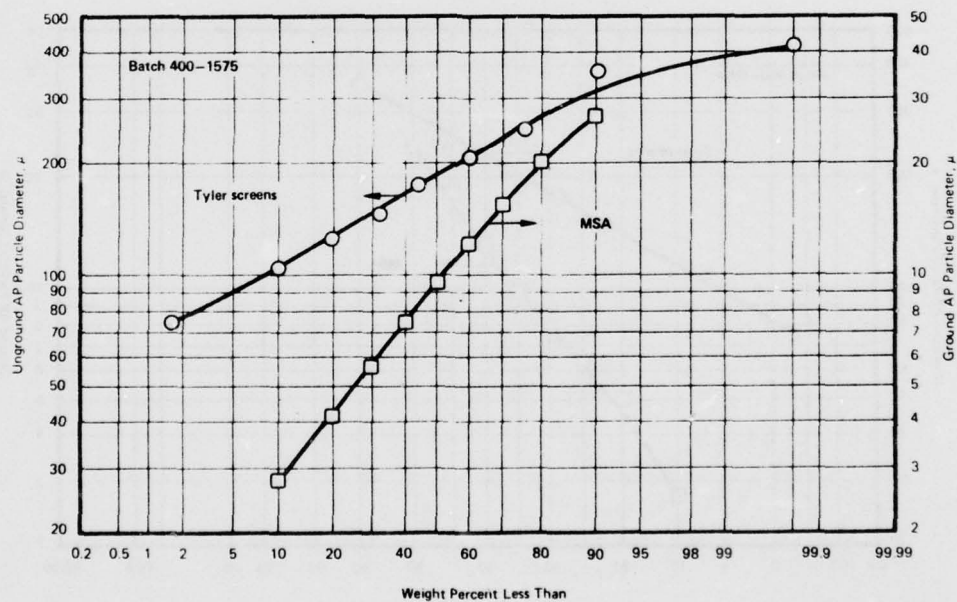
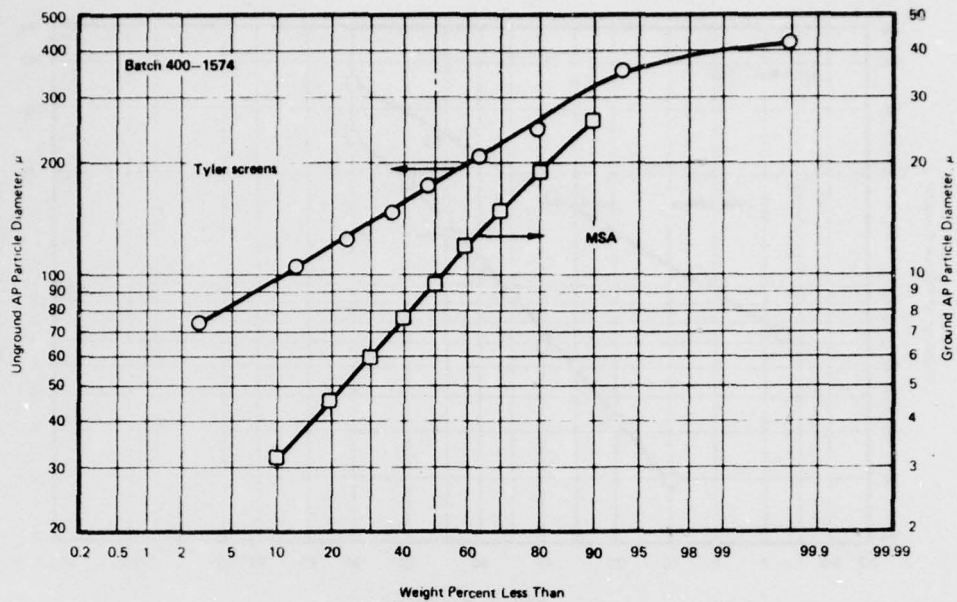
This section presents the AP particle size distributions in terms of cumulative percentages for both the ground and unground AP. The ground AP particle size distributions were determined by MSA and the unground AP particle size distributions were determined by Tyler Screen Analysis. These data were used to establish the AP grind ratio for those batches where D_{43} was used as the burning rate control. All data are presented by batch number.

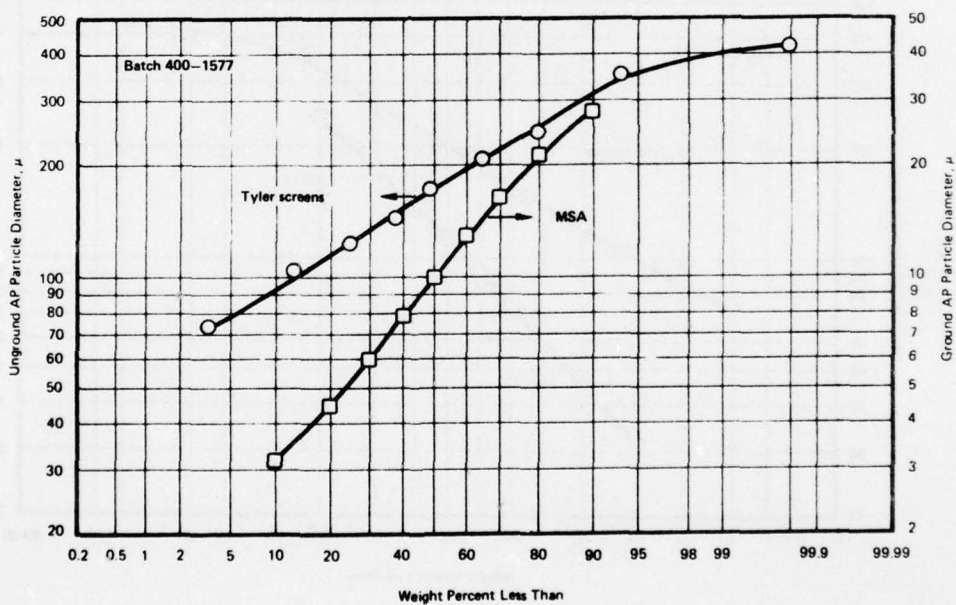
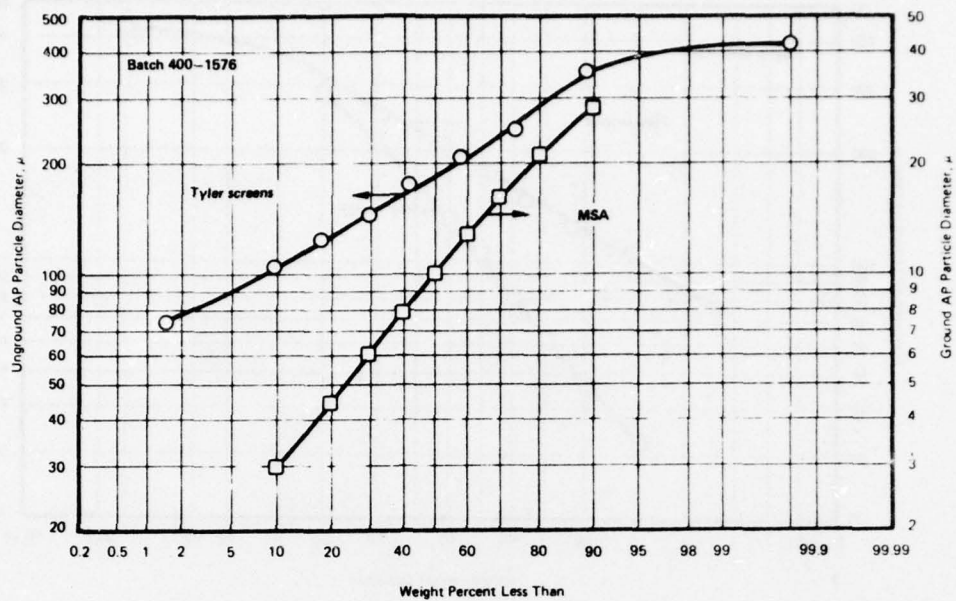


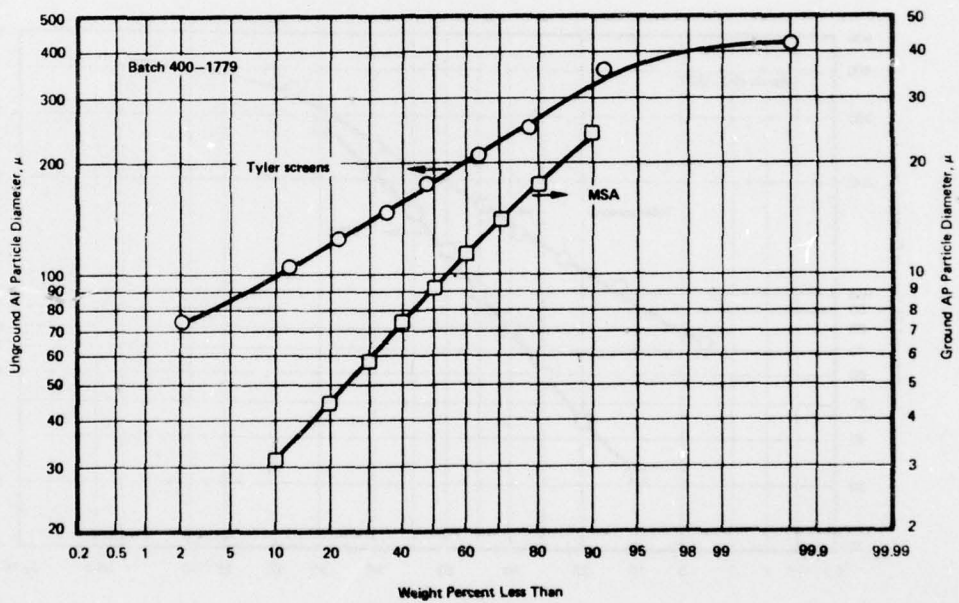
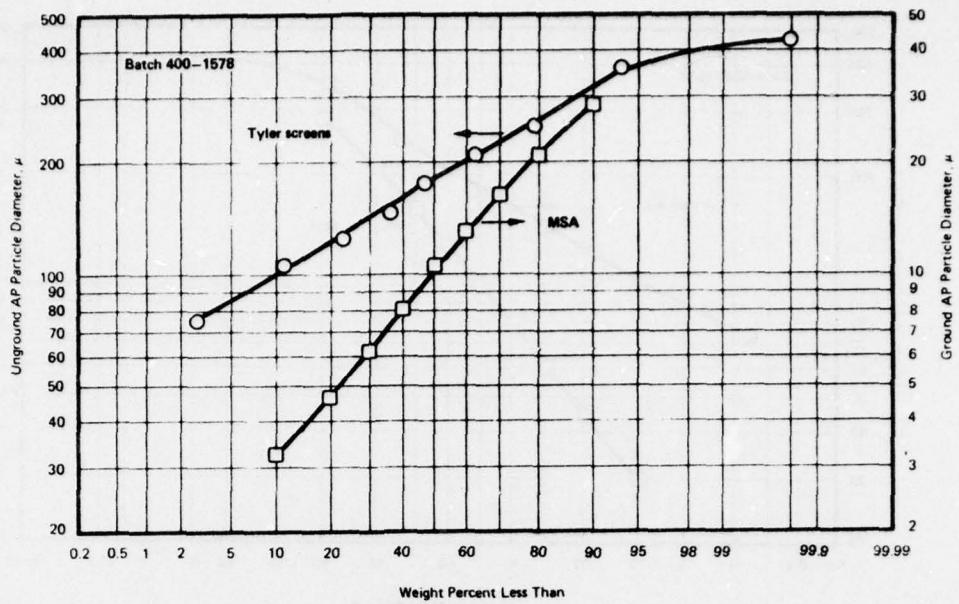


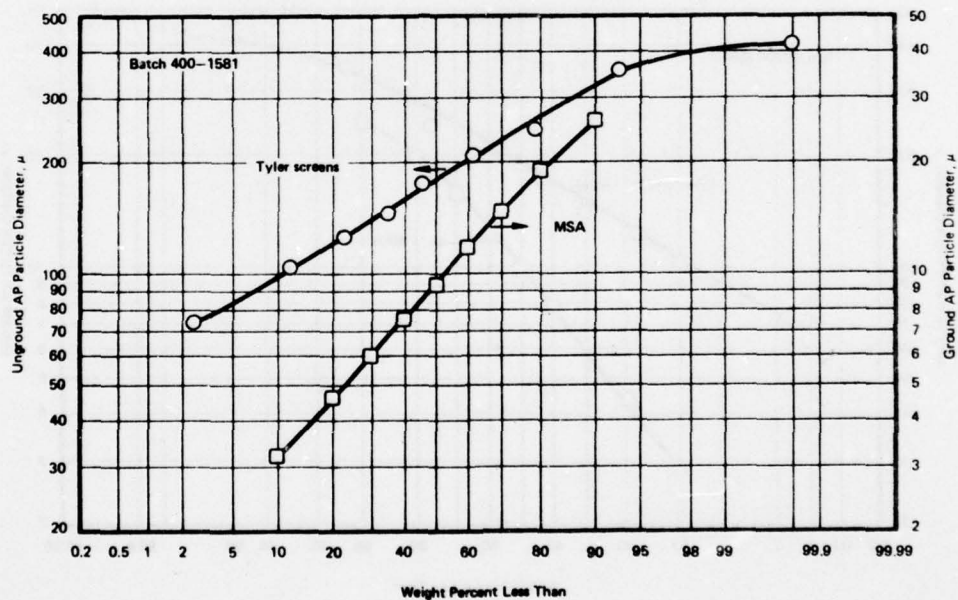
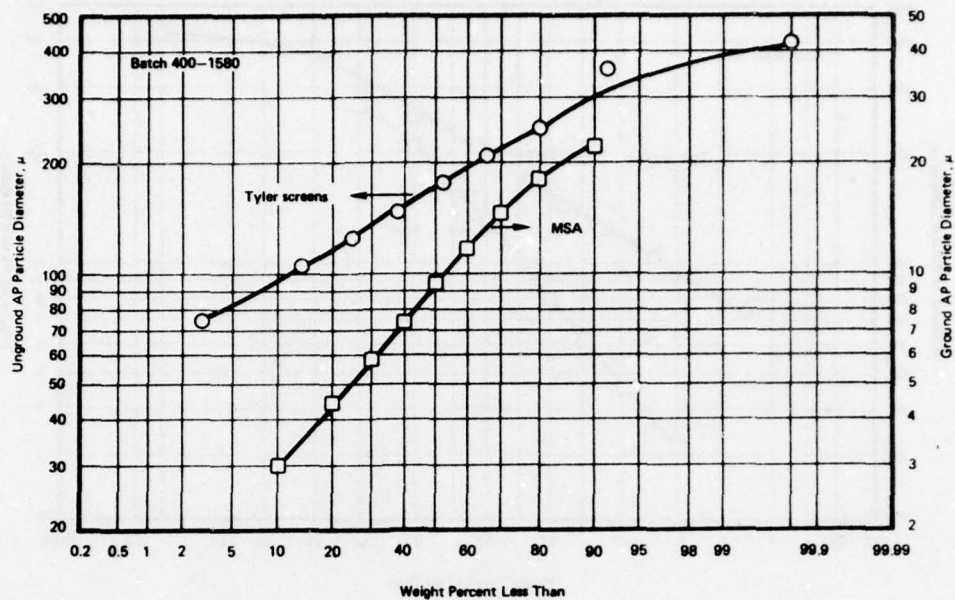


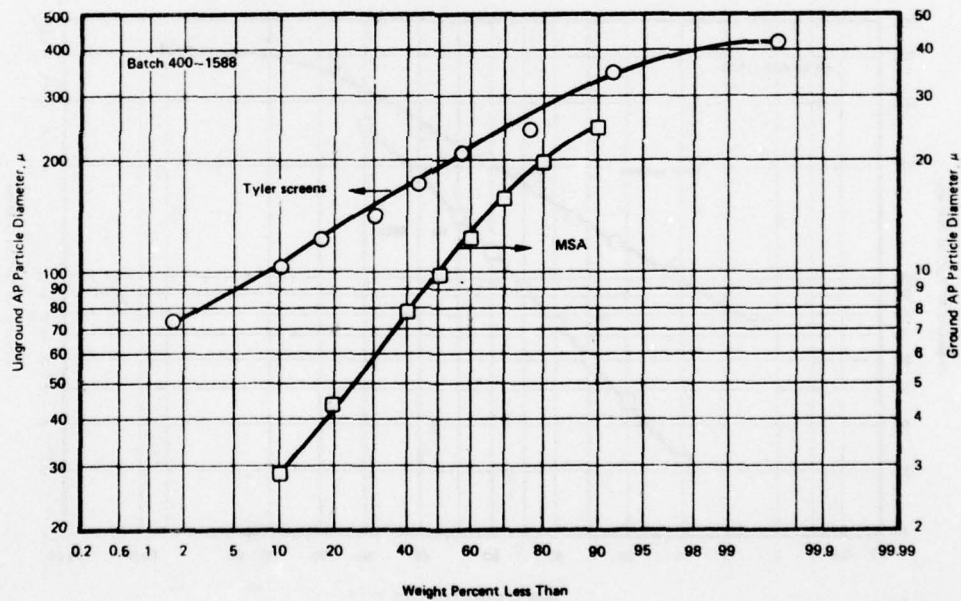
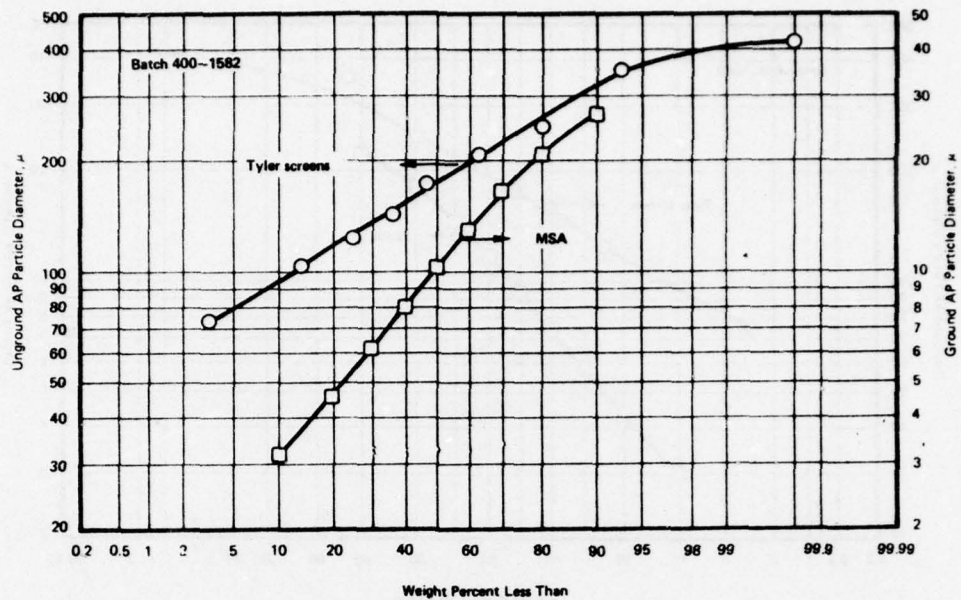


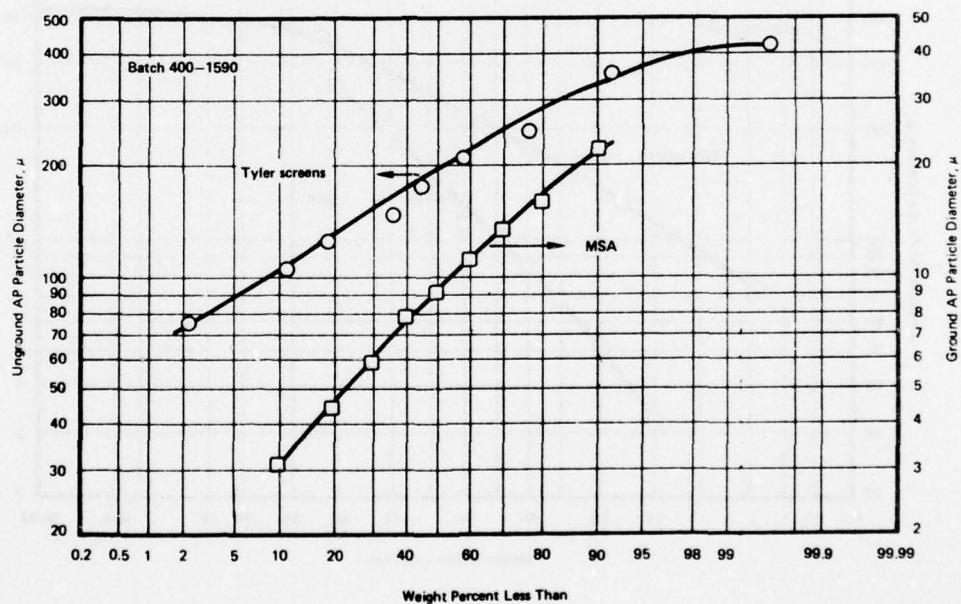
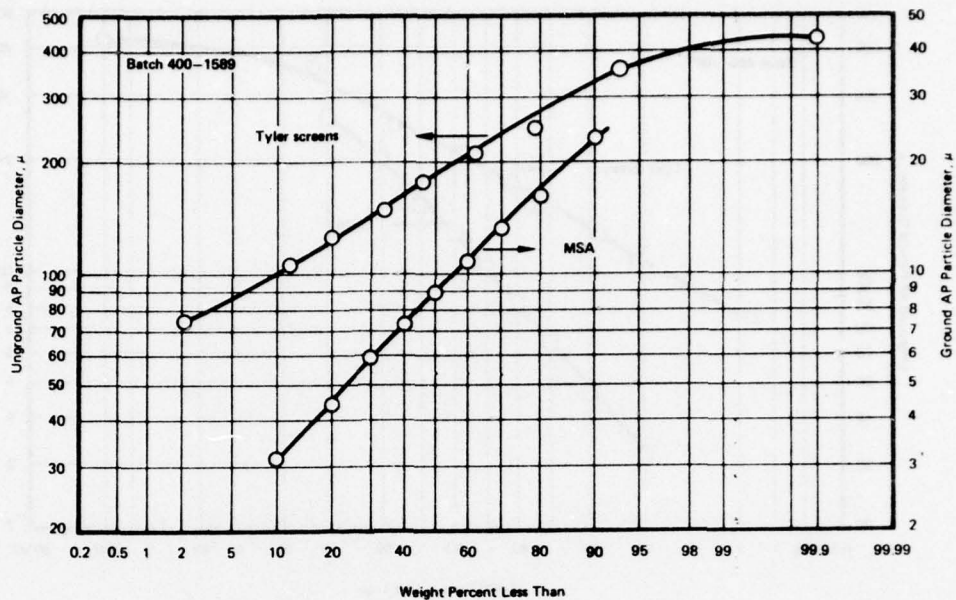


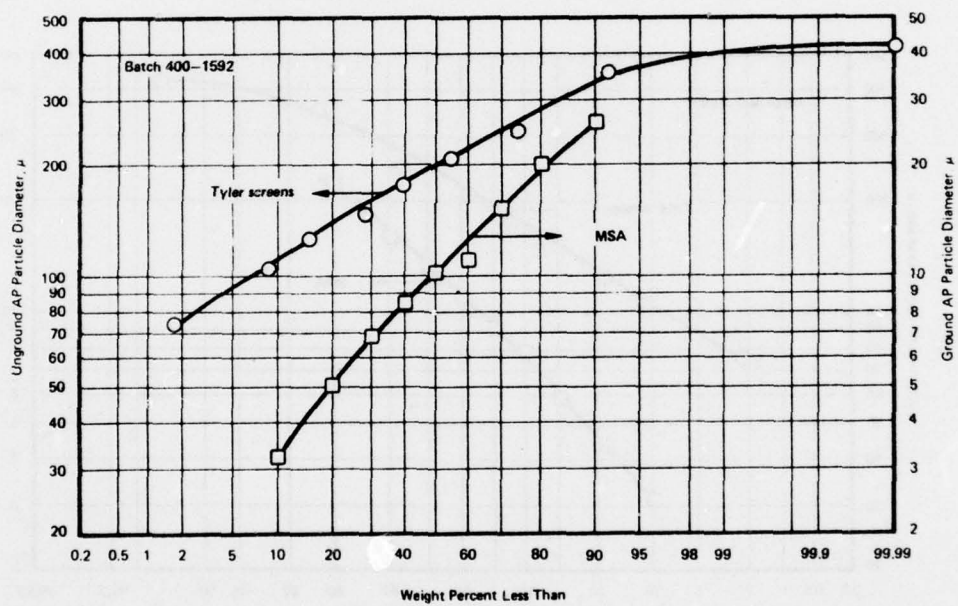
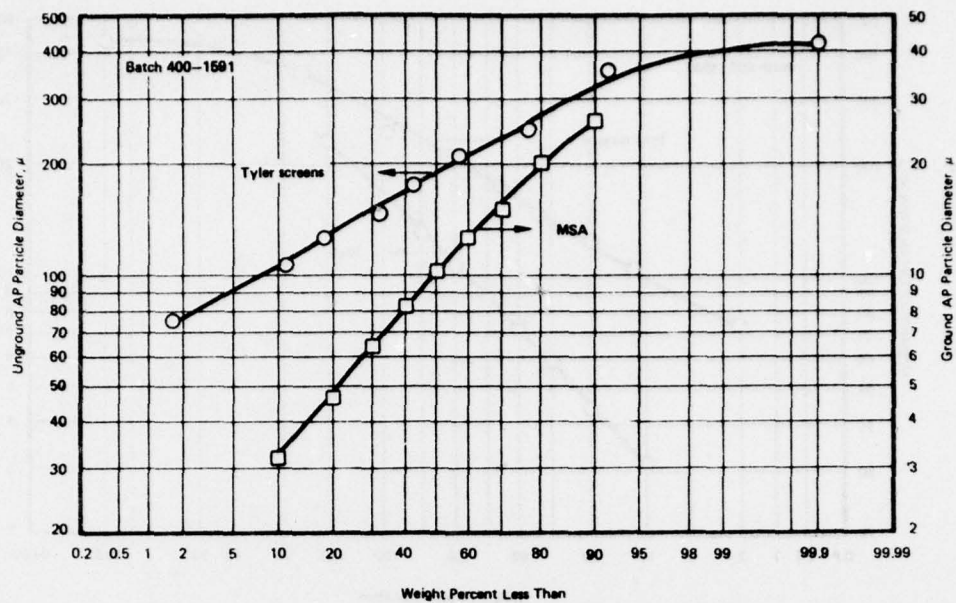


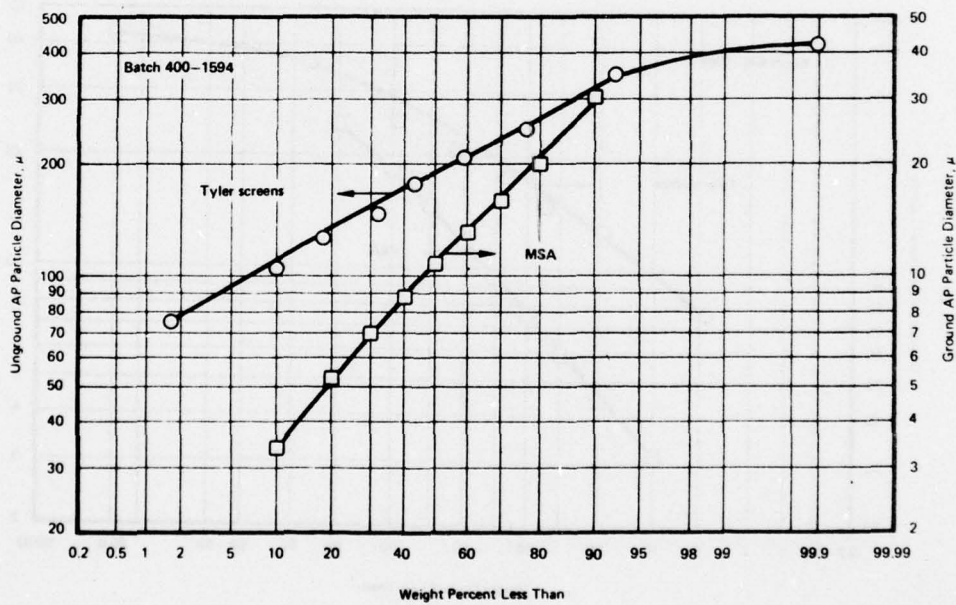
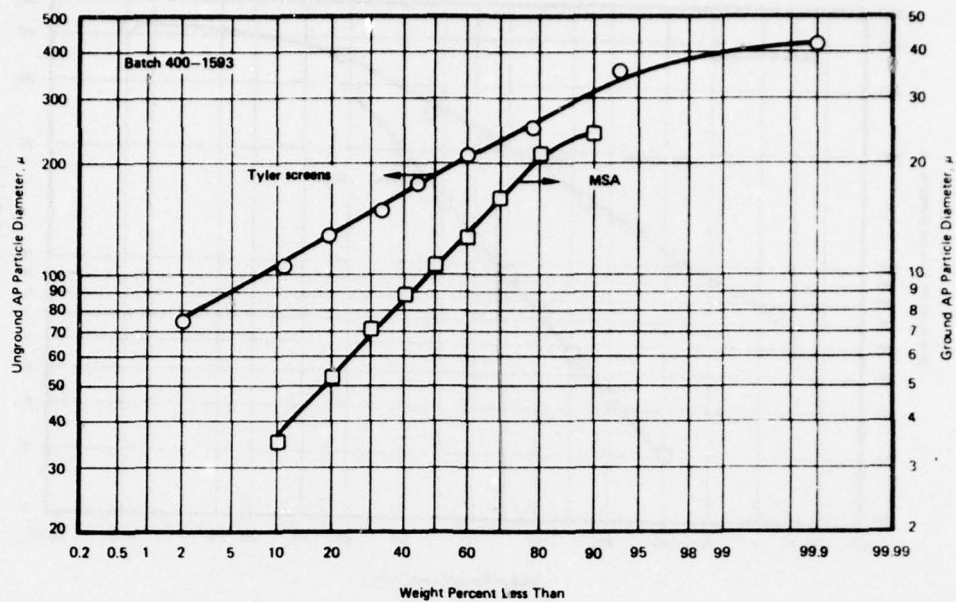


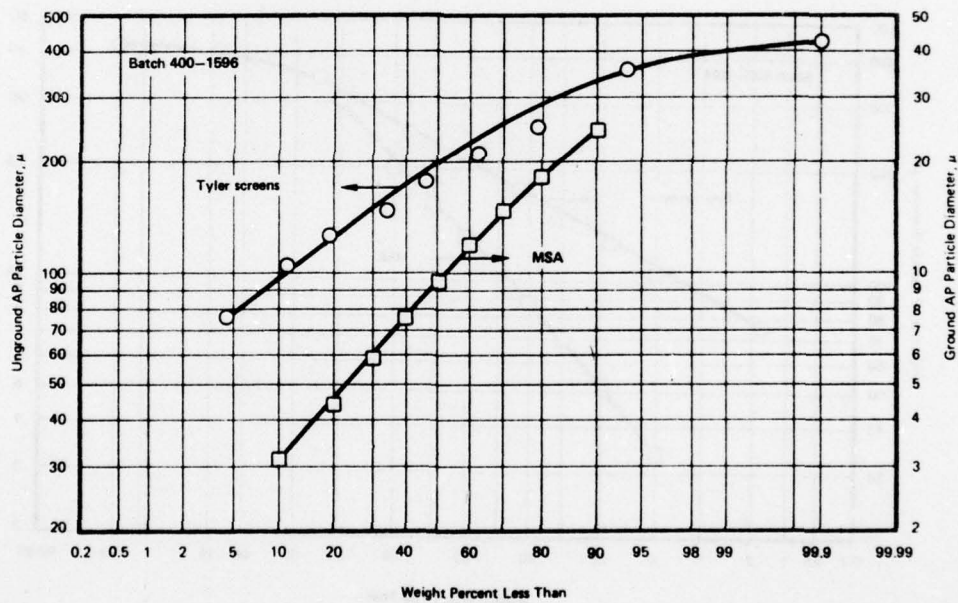
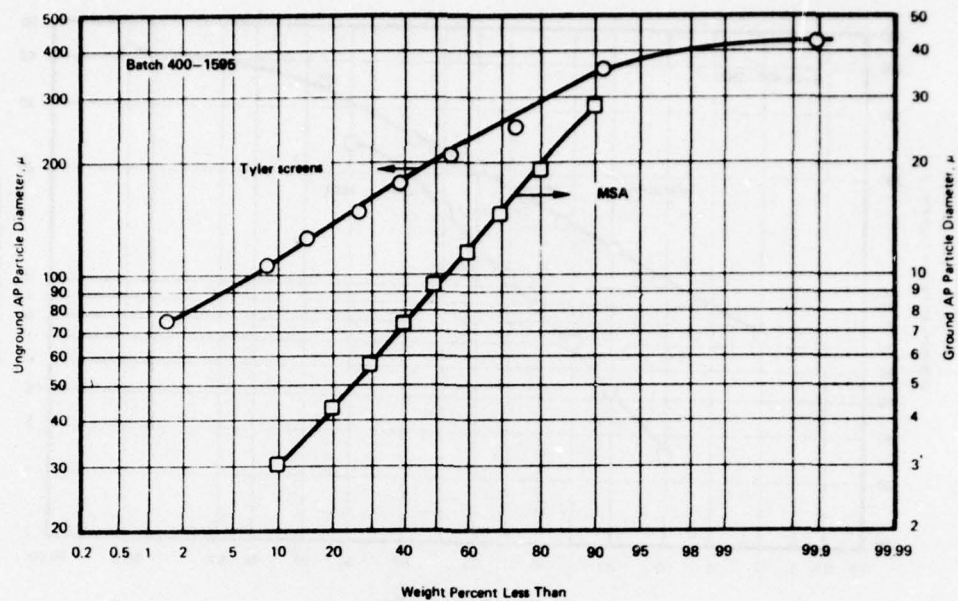


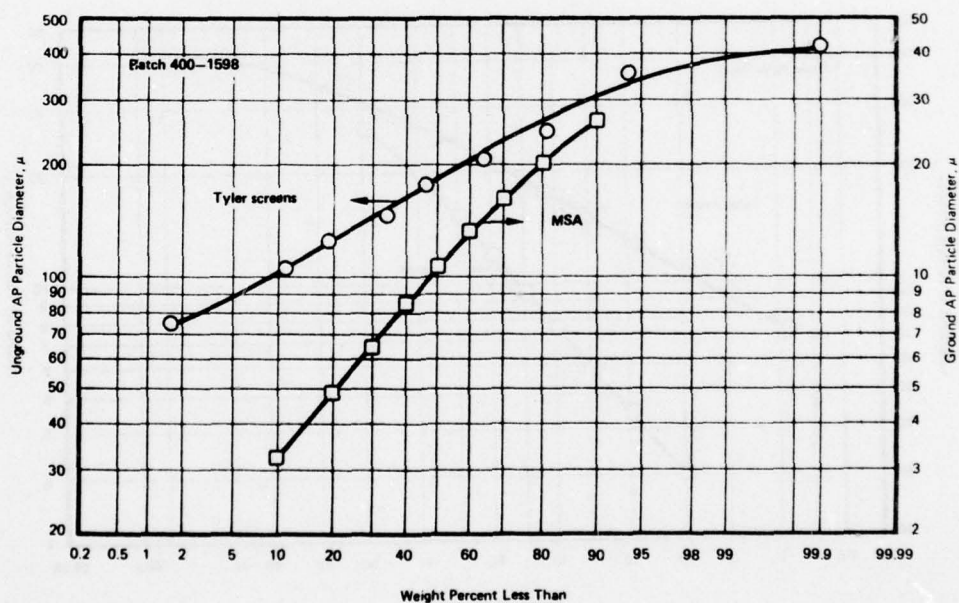
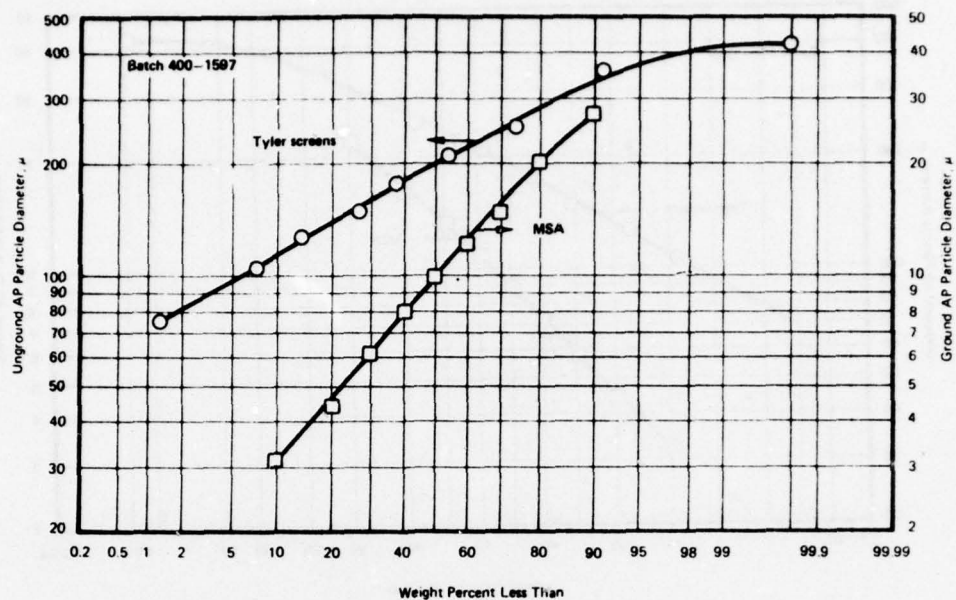


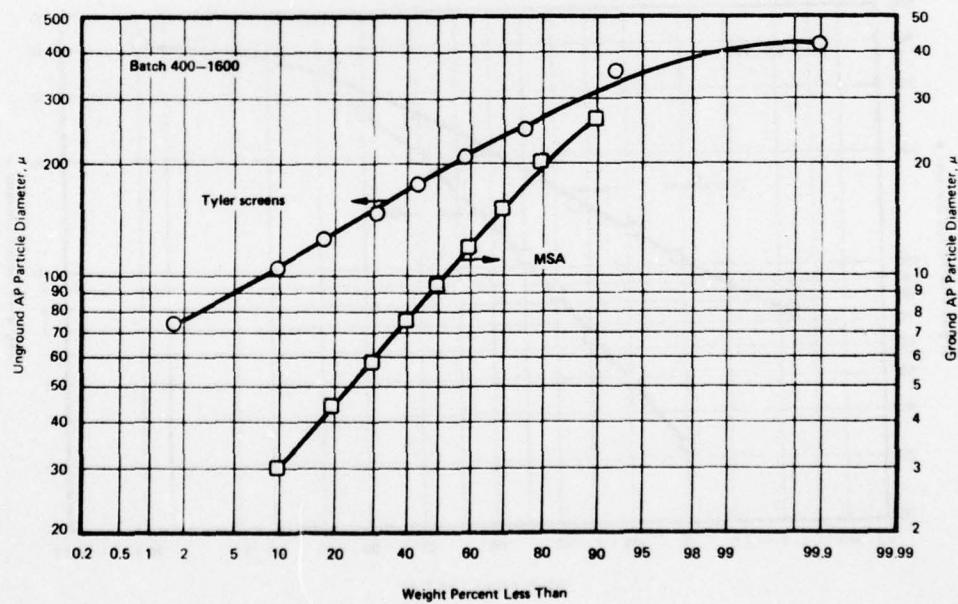
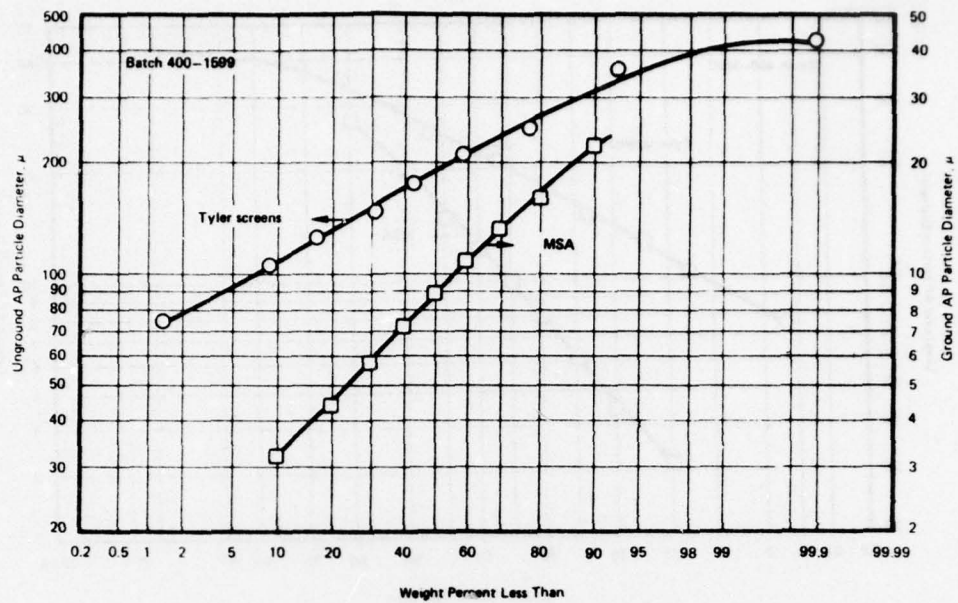


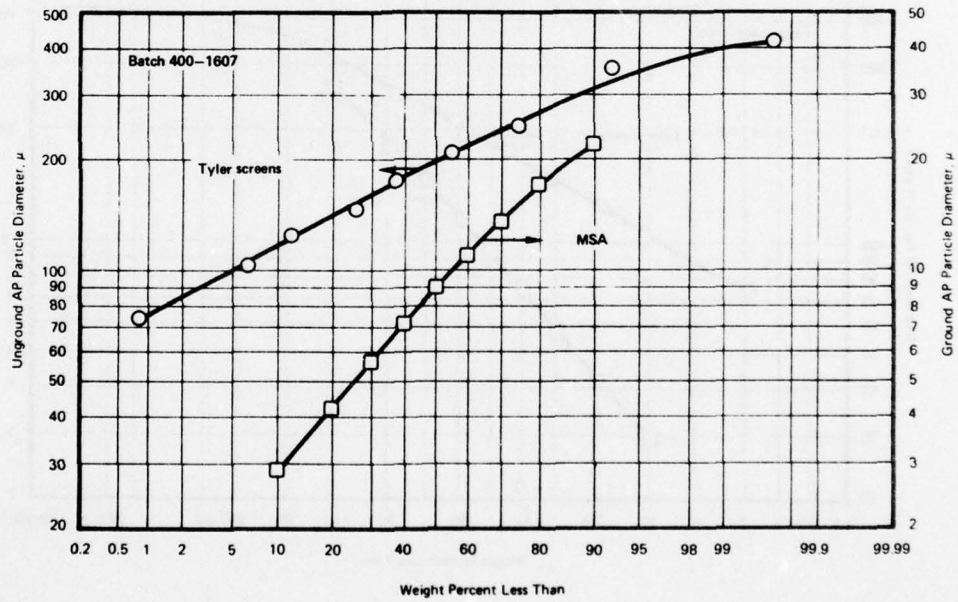
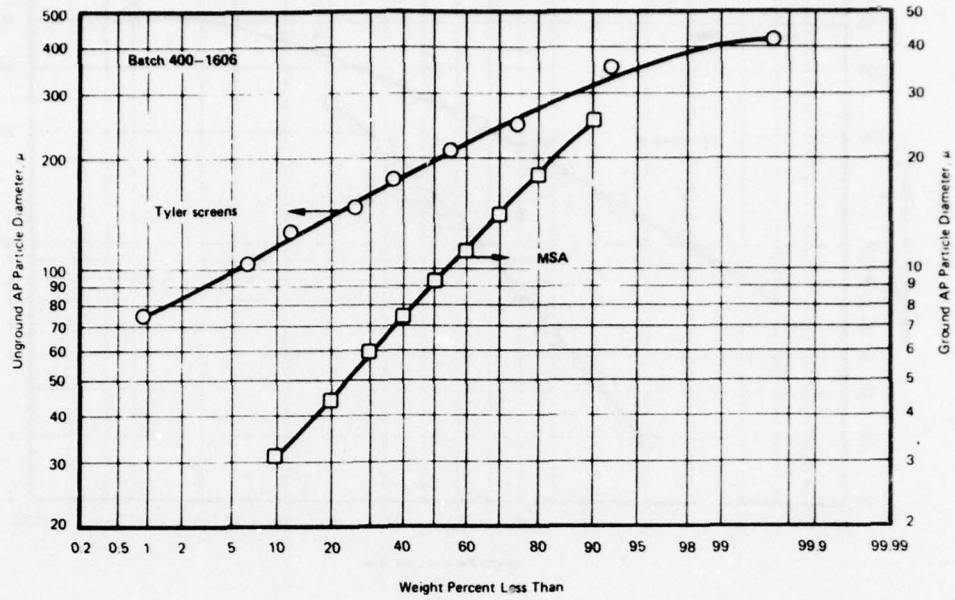


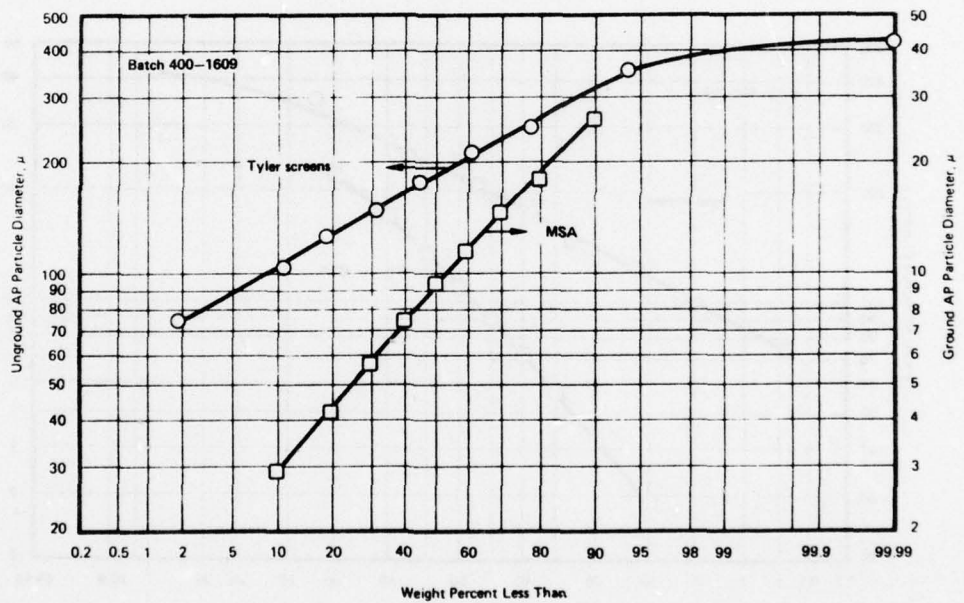
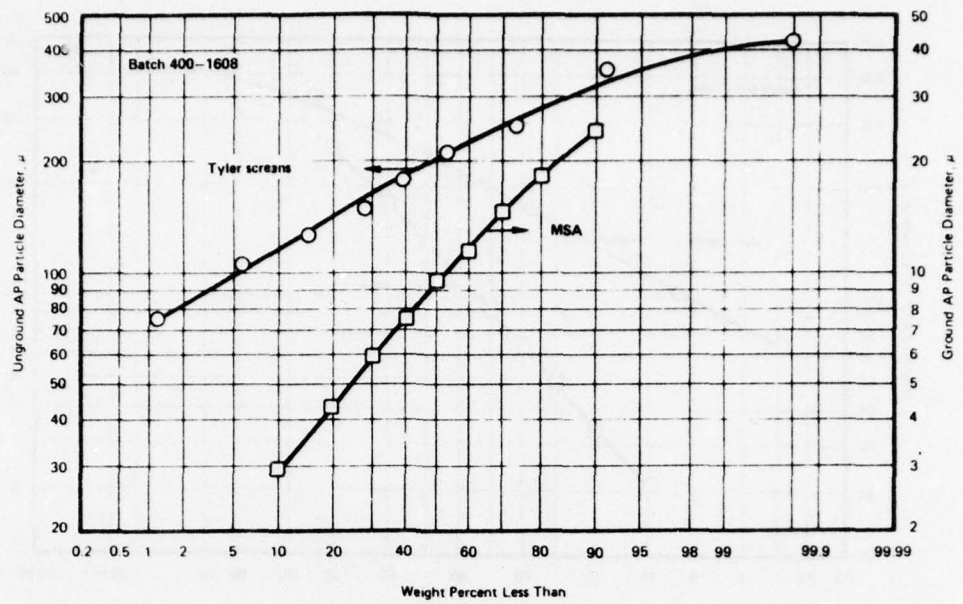


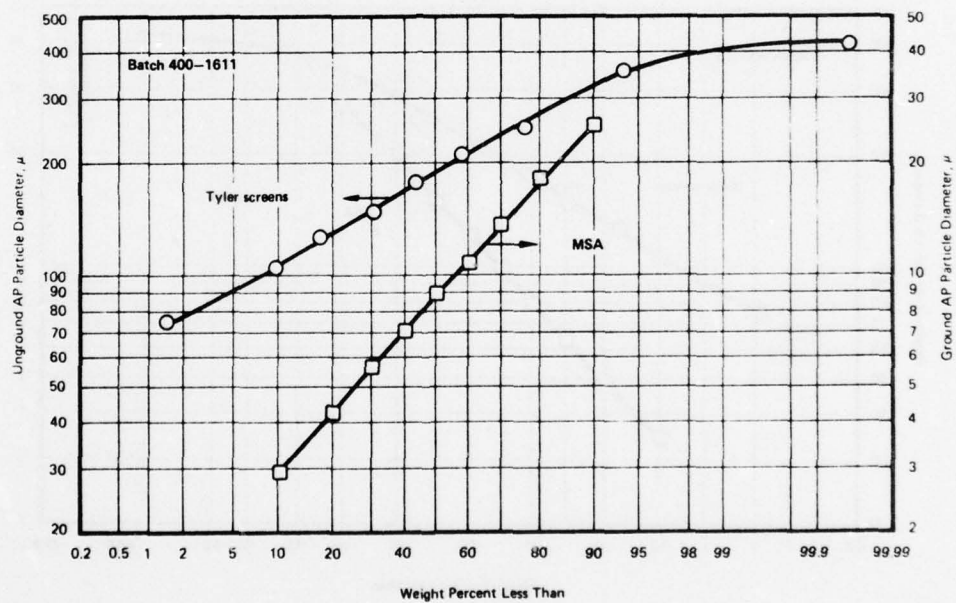
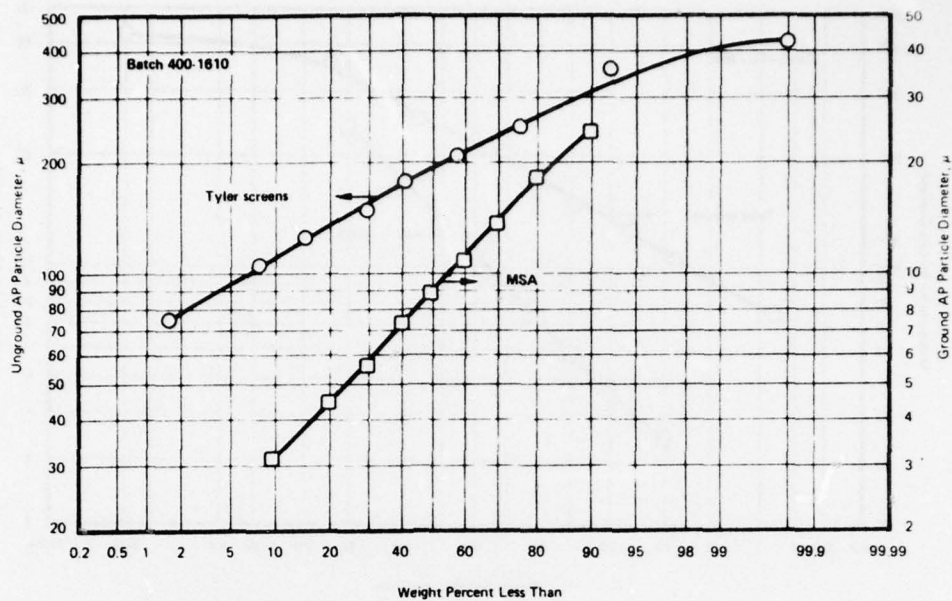










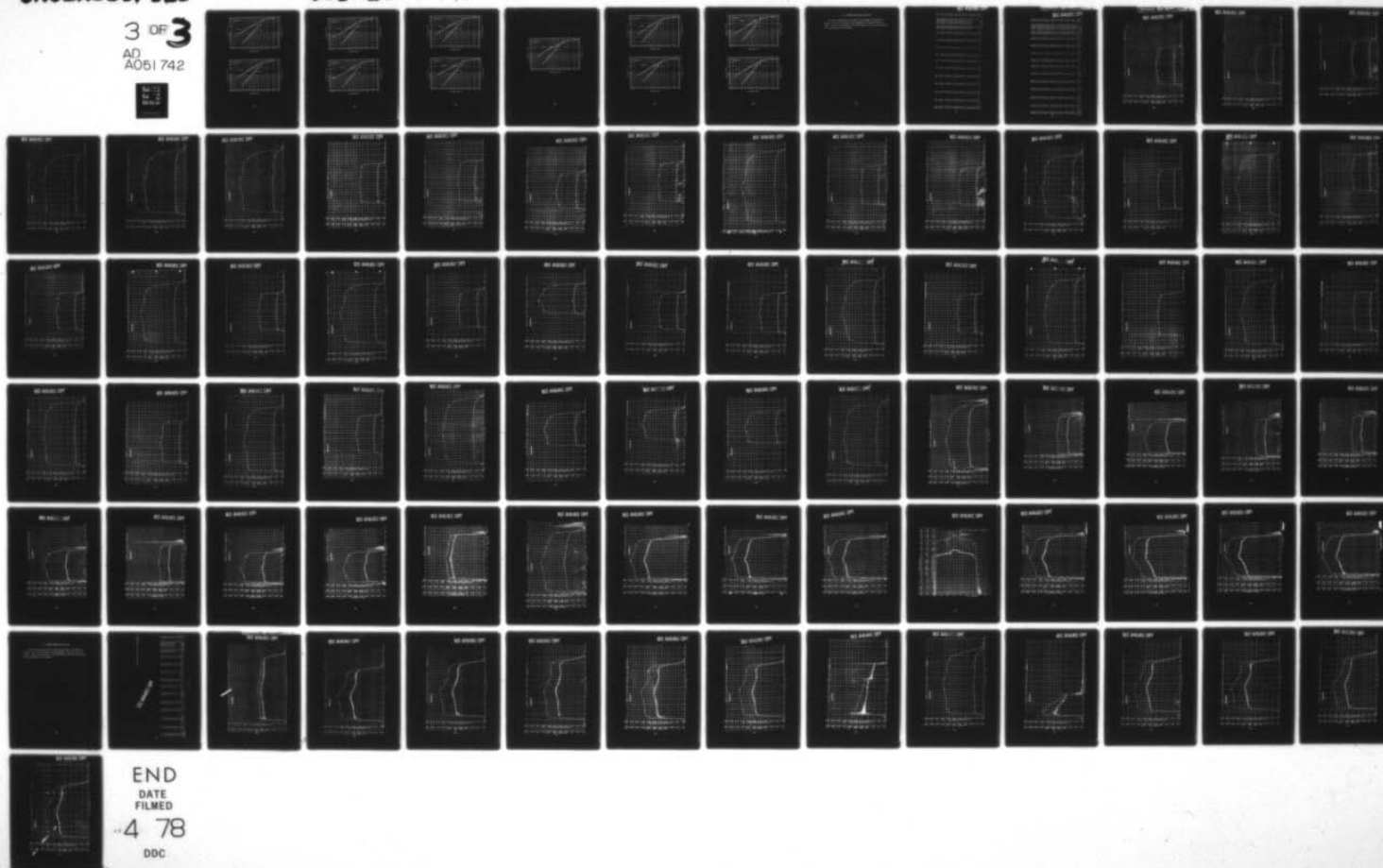


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UNITED TECHNOLOGIES CORP SUNNYVALE CALIF CHEMICAL SY--ETC F/G 21/9.2
84-INCH PROPELLANT CARTRIDGES AND GRAINS. VOLUME II. PROPELLANT--ETC(U)
NOV 77 T V O'HARA, J B HENRY, W A STEPHEN F04611-76-C-0010
CSD-2579-FR AFRPL-TR-77-92 NL

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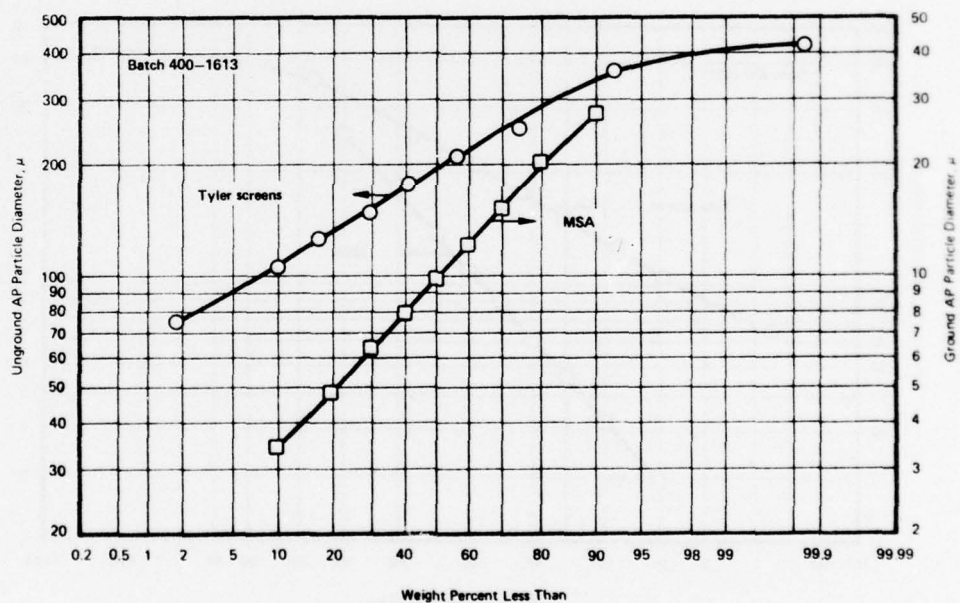
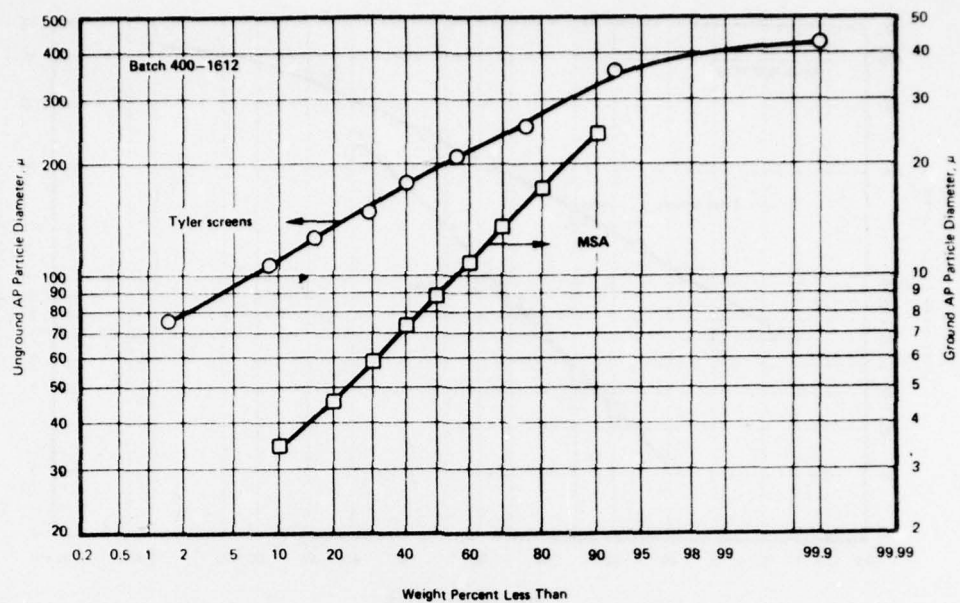
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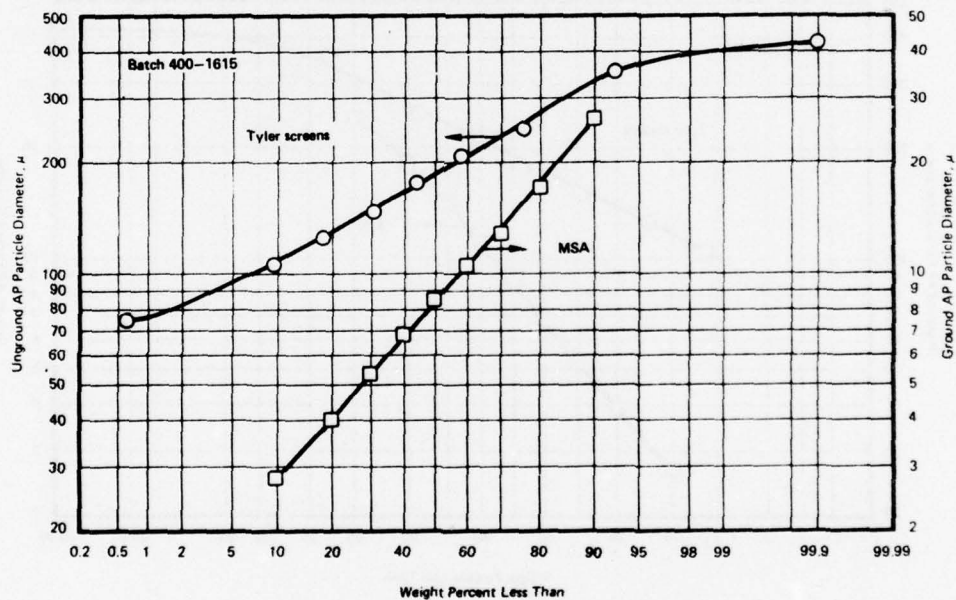
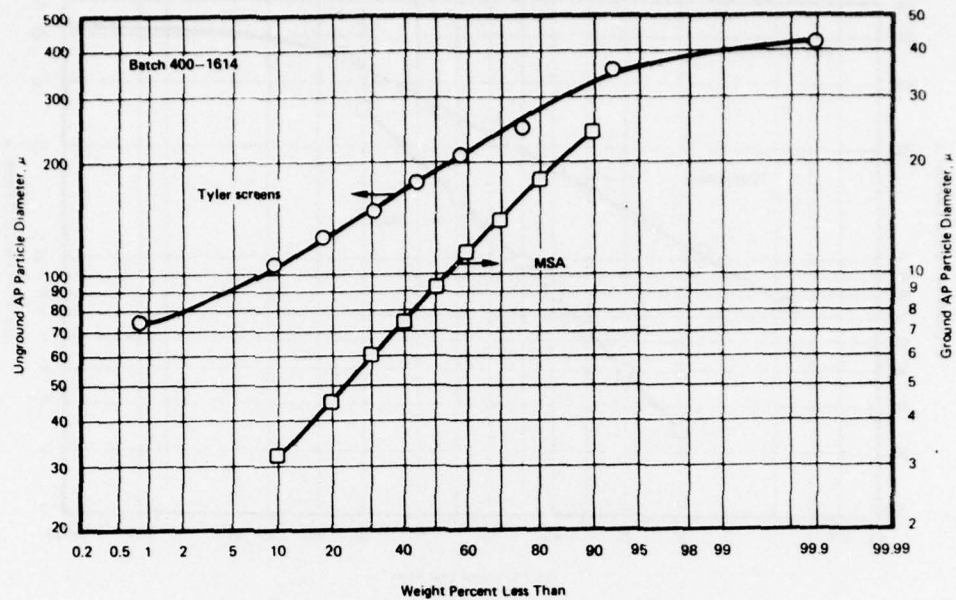
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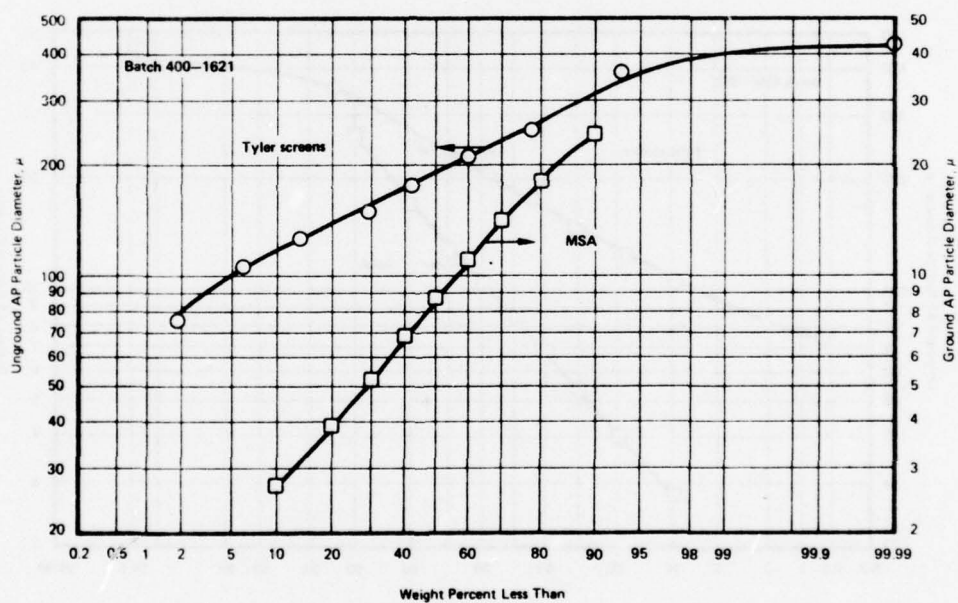
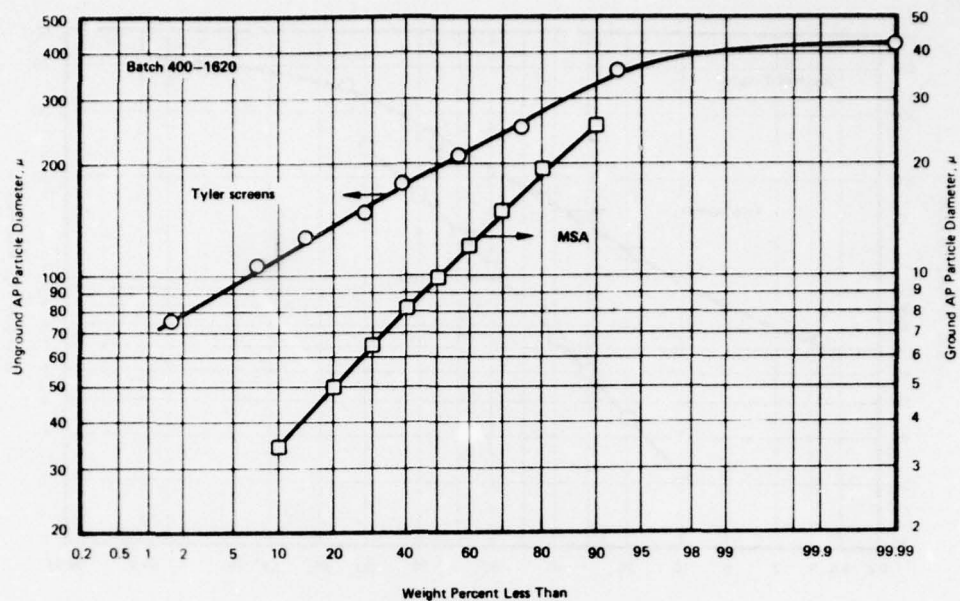
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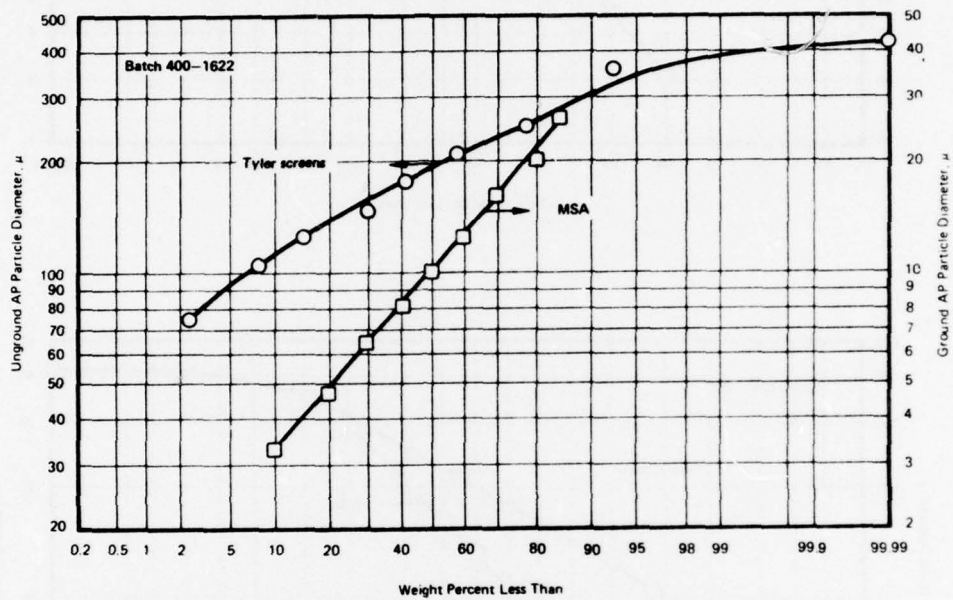


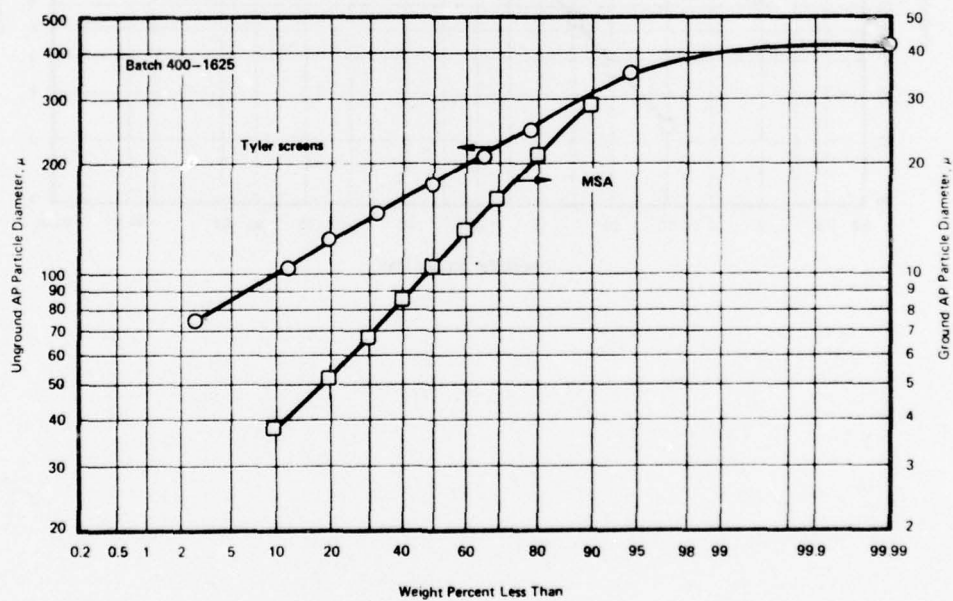
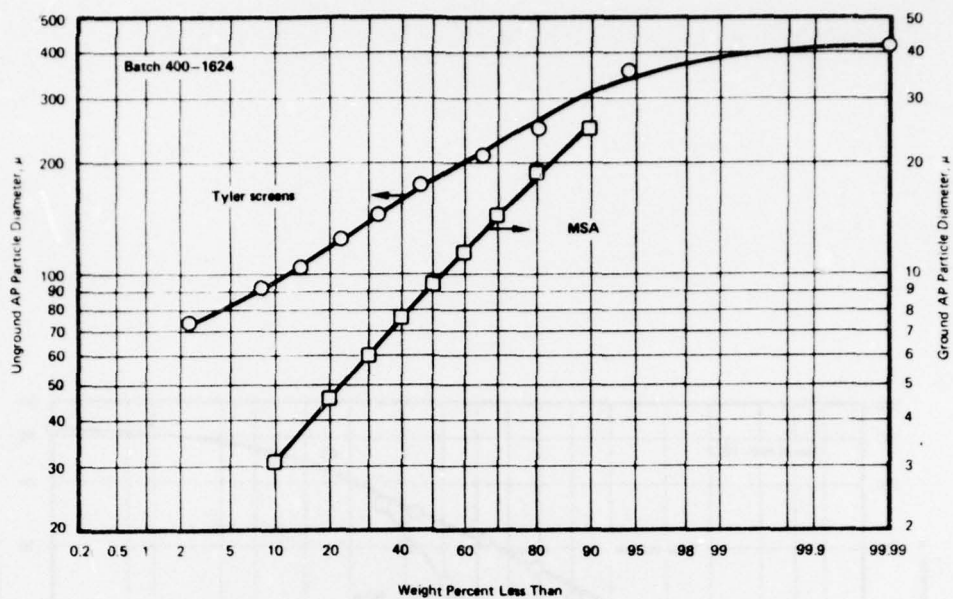
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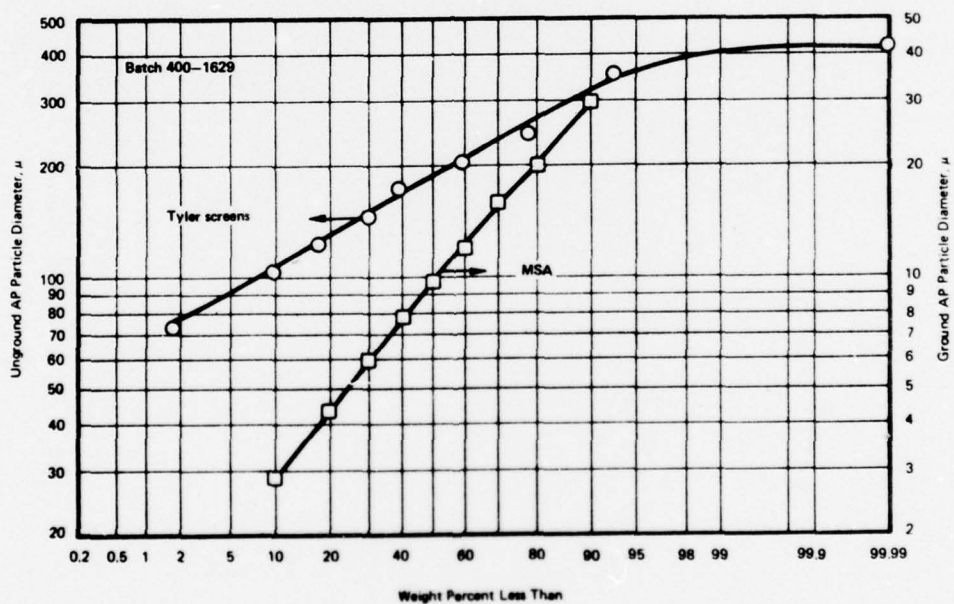
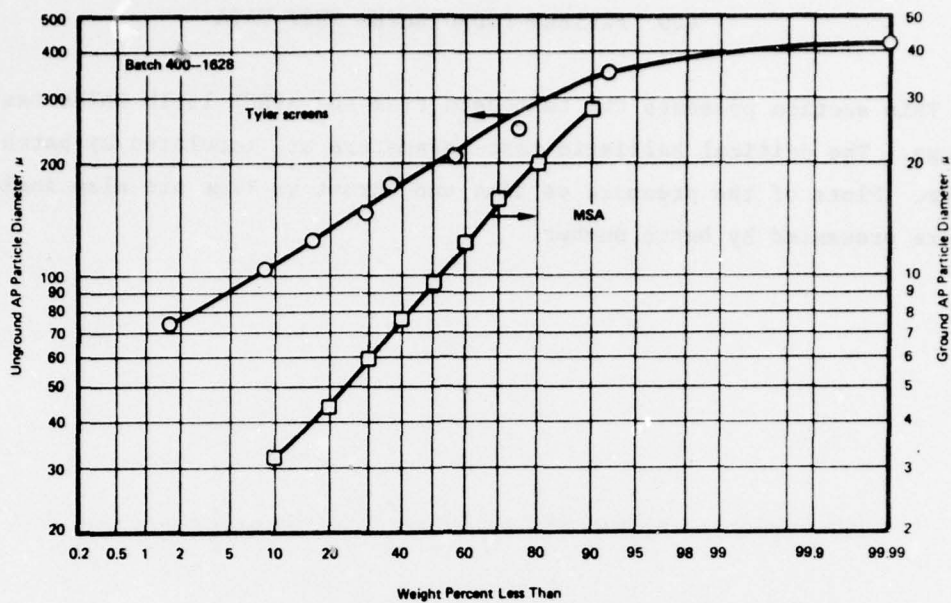












4.0 FIFTEEN-POUND BATES TEST DATA

This section presents the test data from the AFRPL 15-lb BATES test firings. The critical ballistic test parameters are tabulated by batch number. Plots of the pressure vs time and thrust vs time are also included and are presented by batch number.

15-LB BATES DATA, 70°F

Batch No.	Propellant Cast in Se-In. Cartridge			Propellant Weight, lb	Initial Throat Diameter, in.	Throat Erosion Rate, mils/sec	Expansion Ratio	Action Time, sec	Action Time		Burning Rate, in./sec	Measured c*, ft/sec	Delivered Specific Impulse, sec	Isp, 15-deg HA MC, sec	Efficiency Isp, 15-deg HA MC, %
	P/N	S/N							Average Chamber Pressure, psia	Chamber Rate, in./sec					
1450	N/A	N/A	N/A	14.13	1.096	2.0	9.649	2.747	833	0.386	0.491	4.991	239.3	241.6	0.915
1450	N/A	N/A	N/A	14.13	1.095	1.8	9.638	2.769	830	0.381	0.491	5.025	239.0	241.6	0.915
1450	N/A	N/A	N/A	14.13	1.093	2.2	9.634	2.749	831	0.385	0.491	4.966	237.5	240.0	0.909
1450	N/A	N/A	N/A	13.595	0.958	6.0	9.549	2.162	1.328	0.491	0.491	5.071	247.9	241.4	0.9135
1450	N/A	N/A	N/A	13.97	0.963	6.2	9.435	2.269	1.287	0.469	0.480	5.062	247.8	241.7	0.915
1450	N/A	N/A	N/A	14.01	0.961	7.2	9.429	2.218	1.333	0.480	0.480	5.105	247.7	241.1	0.9127
1454	C11479-01-01	2579-02	14.1	1.091	1.73	1.73	9.76	2.896	800	0.361	0.491	5.015	237.9	241.1	0.9136
1455	C11479-01-01	2579-02	14.03	0.965	6.0	1.94	9.355	2.494	1.164	0.419	0.465	5.052	244.8	240.5	0.9111
1456	C11479-01-01	2579-02	14.22	1.092	1.94	1.94	9.751	2.832	831	0.365	0.479	5.071	237.8	240.1	0.9097
1457	C11479-02-01	2579-02	13.82	0.959	5.8	5.8	9.50	2.332	1.253	0.479	0.479	5.040	246.2	240.7	0.9112
1458	C11479-02-01	2579-02	13.91	1.089	1.74	1.74	9.805	3.424	895	0.407	0.407	5.046	240.0	240.5	0.9110
1459	C11479-01-01	2579-01	14.1	0.963	6.5	6.5	9.411	2.307	1.268	0.453	0.453	5.056	246.8	241.0	0.912
1460	C11479-01-01	2579-01	14.07	1.110	1.6	1.6	9.616	2.83	817	0.373	0.444	5.087	237.4	240.1	0.908
1461	C11479-01-01	2579-01	14.12	0.967	6.8	6.8	9.324	2.353	1.243	0.444	0.444	5.076	246.2	240.9	0.9115
1462	C11479-01-01	2579-01	13.86	1.106	1.77	1.77	9.543	2.823	799	0.374	0.374	5.089	237.4	240.5	0.911
1463	C12185-01-01	2579-01	14.09	0.967	5.7	5.7	9.399	2.354	1.230	0.446	0.446	5.015	244.3	239.2	0.9054
1464	C12185-01-01	2579-01	14.05	1.096	1.8	1.8	9.674	2.755	833	0.381	0.458	5.035	238.0	240.3	0.910
1465	C12185-01-01	2579-01	13.93	0.970	5.5	5.5	9.342	2.286	1.251	0.358	0.358	5.024	245.7	240.3	0.910
1495	C11479-01-01	2579-07	14.09	1.045	1.88	1.88	9.675	2.667	863	0.399	0.399	5.015	238.4	240.0	0.9085
1496	C11479-01-01	2579-07	14.07	0.961	6.17	6.17	9.446	2.108	1.395	0.505	0.505	5.116	247.7	240.5	0.9104
1497	C11479-01-01	2579-07	14.07	1.095	1.69	1.69	9.709	2.672	854	0.399	0.399	5.064	238.2	239.8	0.908
1498	C11479-01-01	2579-07	14.09	0.958	2.1	2.1	9.448	2.093	1.442	0.509	0.509	5.189	247.2	239.6	0.907
1499	C11479-01-01	2579-07	13.97	1.092	3.73	3.73	9.634	2.684	839	0.396	0.396	4.971	238.0	240.2	0.910
1502	C11479-03-01	2579-08	14.17	0.965	6.5	6.5	9.384	2.167	1.354	0.492	0.492	5.025	246.6	240.0	0.908
1500	C11479-03-01	2579-08	14.18	0.963	7.3	7.3	9.425	2.124	1.364	0.502	0.502	5.042	247.6	240.8	0.914
1503	C11479-03-01	2579-08	14.04	1.092	2.8	2.8	9.766	2.677	1.250	0.393	0.393	4.936	238.4	240.5	0.911
1505	C11479-01-01	2579-09	14.2	1.099	1.4	1.4	9.65	2.881	794	0.366	0.366	4.968	236.5	240.1	0.909
1506	C11479-01-01	2579-09	14.28	0.962	7.6	7.6	9.469	2.164	1.362	0.485	0.485	5.007	246.6	239.7	0.907
1507	C11479-01-01	2579-09	14.2	1.096	2.42	2.42	9.625	2.688	849	0.392	0.392	4.959	238.4	240.7	0.91
1509	C11479-01-01	2579-09	14.22	1.098	2.4	2.4	9.61	2.684	868	0.386	0.386	5.074	239.3	240.7	0.9117
1510	C11479-03-01	2579-10	14.18	0.967	6.8	6.8	9.38	2.14	1.388	0.492	0.492	5.102	247.7	240.6	0.9105
1511	C11479-03-01	2579-10	13.90	1.098	2.6	2.6	9.618	2.71	831	0.422	0.422	5.039	237.4	239.8	0.9078
1512	C11479-03-01	2579-10	14.16	0.963	7.7	7.7	9.4	2.141	1.396	0.490	0.490	5.106	247.9	240.7	0.9113
1513	C11479-03-01	2579-10	14.2	1.09	2.03	2.03	9.76	2.712	866	0.387	0.387	5.041	239.0	240.5	0.9101
1514	C12185-02-01	2579-06	14.24	0.96	7.0	7.0	9.496	2.126	1.393	0.492	0.492	5.022	247.9	240.6	0.9109
1514	C12185-02-01	2579-06	14.18	1.095	2.4	2.4	8.40	2.691	857	0.406	0.406	5.000	238.9	240.9	0.9122

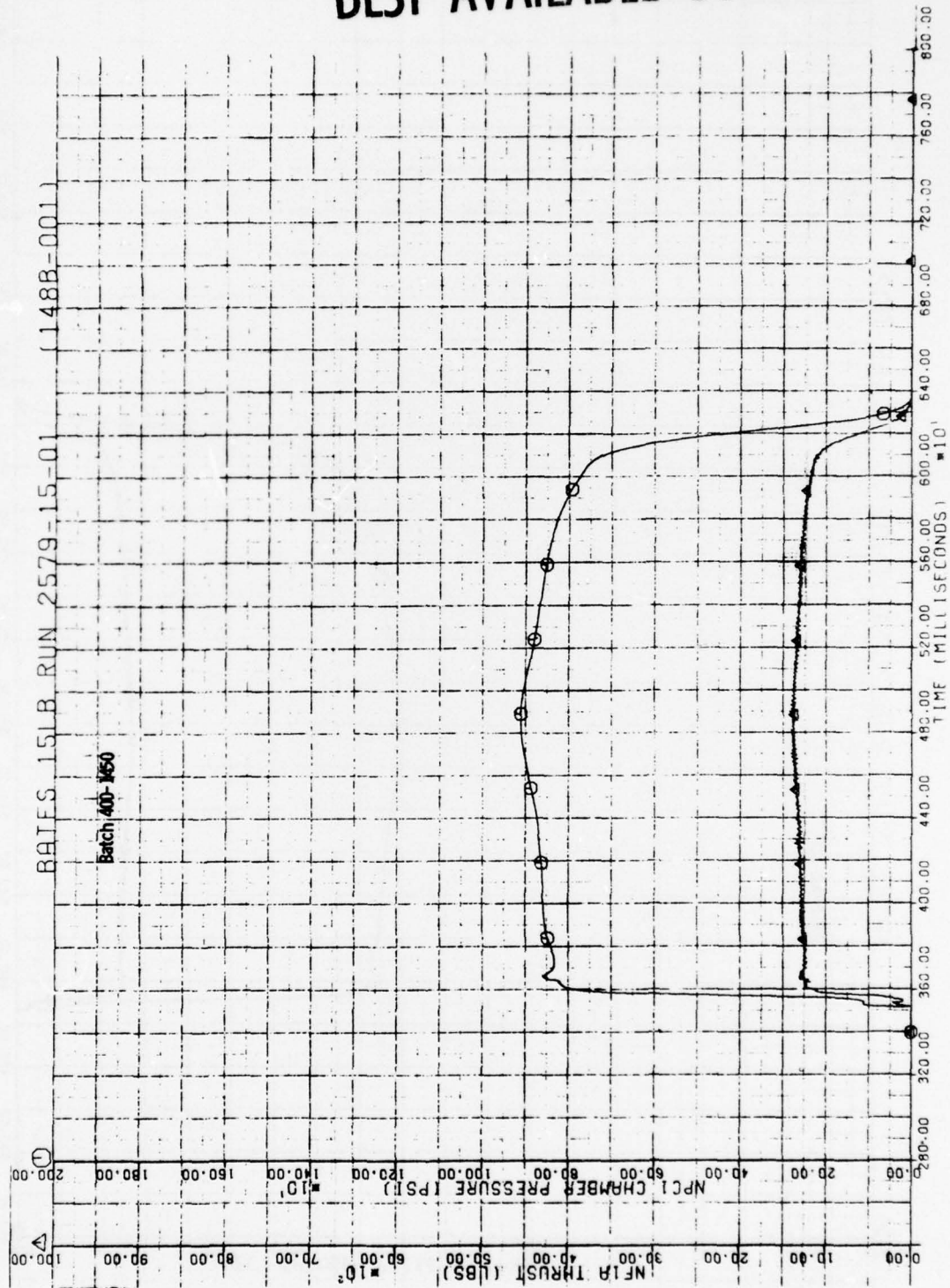
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15-LB BATES DATA, 70°F

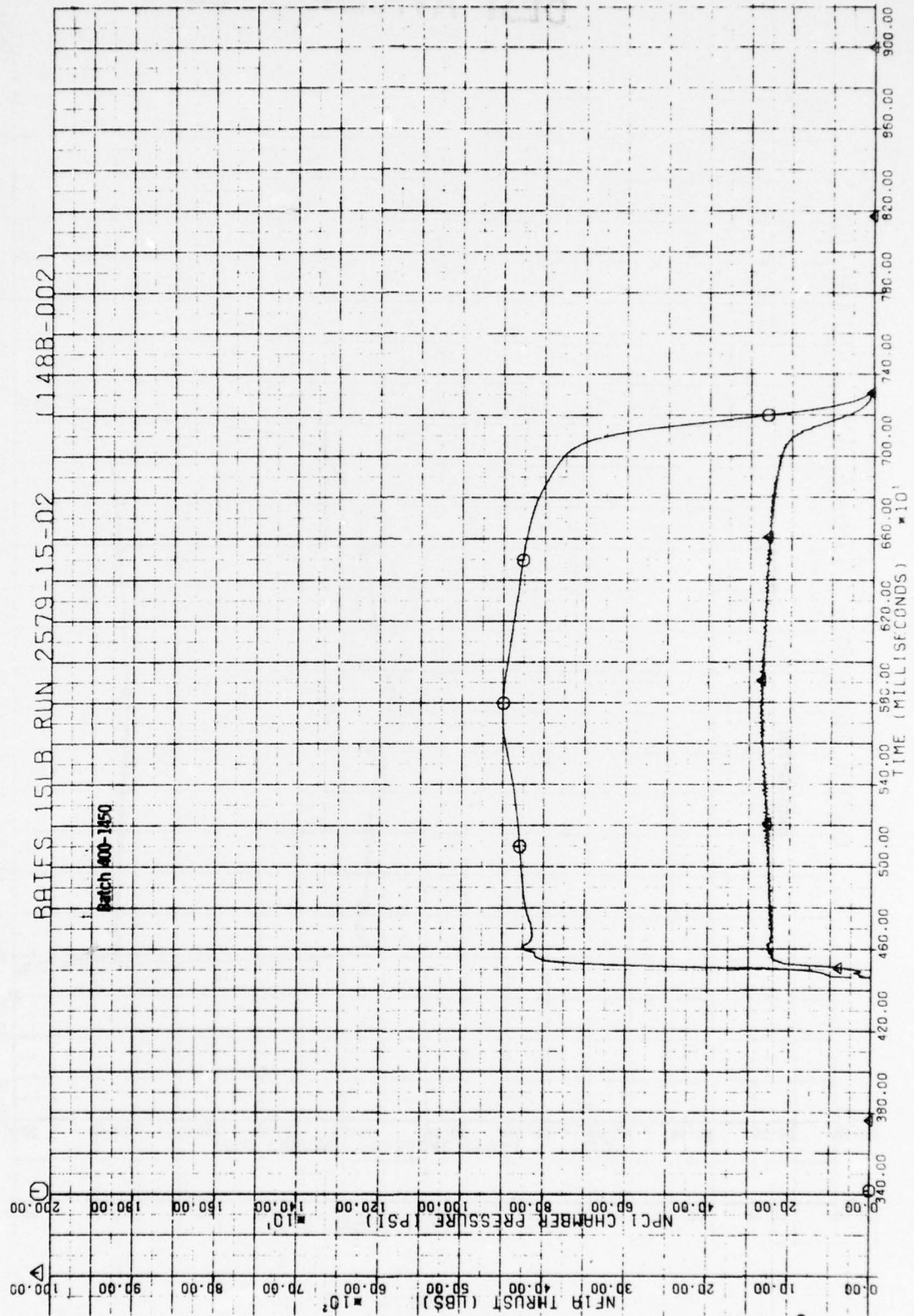
Batch No.	Propellant Cast In		Propellant Weight, lb	Initial Throat Diameter, in.	Throat Erosion Rate, mils/sec	Expansion Ratio	Action Time, sec	Action Time Average Chamber Pressure, psia	Burning Rate, in./sec	Measured c^* , ft/sec	Delivered Specific Impulse, sec	Isp, 15-deg HA MC, sec	Efficiency Isp, 15-deg HA MC, %
	8-in. Cartridge	8-in. Cartridge											
	P/N	S/N											
1515	C12185-02-01	2579-06	13.96	1.098	2.09	9.636	2.628	854	0.398	4.960	238.5	240.3	0.9098
1516	C11479-02-01	2579-12	14.2	1.095	1.62	9.69	2.784	876	0.375	4.963	238.9	241.6	0.9147
1517	C11479-02-01	2579-12	14.18	0.962	6.79	9.44	2.286	1.283	0.460	5.005	247.2	241.2	0.9134
1518	C11479-02-01	2579-12	14.23	1.099	1.62	9.59	2.775	879	0.378	4.964	238.6	241.4	0.914
1519	C11479-02-01	2579-12	14.12	0.965	5.59	9.435	2.323	1.234	0.455	4.993	247.2	241.6	0.914
1520	C11479-02-01	2579-12	14.14	1.114	1.58	9.352	2.843	783	0.371	4.997	237.6	241.5	0.9143
1521	C11479-01-01	2579-11	14.22	0.961	6.2	9.489	2.333	1.282	0.455	5.065	247.2	241.2	0.9132
1522	C11479-01-01	2579-11	14.15	1.093	1.94	9.72	2.841	807	0.372	4.993	237.9	241.2	0.913
1523	C11479-01-01	2579-11	14.14	0.966	6.2	9.538	2.256	1.323	0.471	5.075	248.0	241.4	0.914
1524	C11479-01-01	2579-11	14.2	1.097	1.4	9.635	2.845	810	0.371	4.991	237.9	241.0	0.912
1525	C12185-02-01	2579-08	13.81	0.97	5.44	9.345	2.297	1.231	0.460	5.015	246.5	241.3	0.913
1526	C12185-03-01	2579-09	14.23	1.107	1.6	9.451	2.77	826	0.381	5.050	238.8	241.4	0.9135
1527	C11479-01-01	2579-13	14.1	0.963	6.1	9.48	2.309	1.259	0.452	5.004	246.8	240.8	0.9118
1533	C11479-01-01	2579-14	14.15	0.962	6.28	9.445	2.309	1.259	0.454	4.981	245.9	240.0	0.908
1537	C12185-03-01	2579-11	13.84	0.962	3.0	9.473	2.209	1.298	0.472	5.028	247.0	240.5	0.910
1539	C12185-02-01	2579-12	14.14	0.962	6.36	9.470	2.358	1.262	0.442	5.084	246.8	240.9	0.9118
1541	C12185-01-01	2579-10	14.15	0.961	6.5	9.477	2.231	1.342	0.472	5.119	247.6	240.7	0.9112
1574	C11479-01-01	2579-17	14.05	0.963	6.4	9.458	2.255	1.321	0.470	5.137	248.3	241.8	0.915
1575	C11479-01-01	2579-17	14.02	1.096	2.0	9.674	2.755	838	0.385	5.079	239.6	241.6	0.915
1576	C11479-01-01	2579-17	14.0	0.963	6.4	9.408	2.268	1.473	0.468	5.079	239.9	242.0	0.916
1577	C11479-01-01	2579-17	14.04	1.097	1.8	9.628	2.756	840	0.387	5.079	239.9	242.3	0.916
1578	C11479-01-01	2579-17	14.08	1.098	1.8	9.648	2.773	908	0.381	5.001	239.4	241.7	0.915
1579	C11479-03-02	2579-18	14.08	0.966	2.227	9.389	2.227	1.319	0.477	5.079	249.1	242.4	0.9176
1580	C11479-03-02	2579-18	14.15	1.102	2.0	9.566	2.751	911	0.386	5.015	239.4	241.6	0.915
1581	C11479-03-02	2579-18	14.02	0.966	2.16	9.363	2.739	1.311	0.475	5.088	250.3	243.7	0.923
1582	C11479-03-02	2579-18	14.14	0.97	7.2	9.23	2.209	1.313	0.481	5.067	247.6	241.2	0.913
1588	C11479-01-01	2579-19	13.92	1.208	0.7	8.012	3.041	684	0.348	5.069	232.8	242.2	0.917
1590	C11479-01-01	2579-19	14.03	0.964	8.7	9.233	2.184	1.343	0.485	5.139	248.9	242.2	0.917
1592	C11479-01-01	2579-19	14.06	1.101	2.7	9.41	2.731	831	0.388	5.032	239.6	241.8	0.915
1594	C11479-02-01	2579-20	13.99	1.109	1.1	9.453	2.764	812	0.382	5.035	238.8	241.5	0.914
1596	C11479-02-01	2579-20	14.11	1.093	2.4	9.635	2.687	867	0.394	5.062	240.2	241.4	0.914
1598	C12185-01-01	2579-14	14.04	1.101	2.0	9.542	2.686	846	0.394	5.037	239.2	241.0	0.912
1606	C11479-01-01	2579-21	14.2	1.110	19.4	9.366	2.835	802	0.372	5.062	239.0	241.9	0.916
1607	C11479-01-01	2579-21	14.26	1.102	2.3	9.491	2.88	898	0.363	5.021	237.1	240.2	0.9095
1610	C11479-01-01	2579-21	14.09	1.099	2.0	9.534	2.753	831	0.381	5.031	238.9	241.1	0.912
1612	C11479-01-01	2579-22	14.11	1.097	2.0	9.59	2.70	855	0.389	5.054	240.8	242.1	0.916
1614	C11479-01-01	2579-22	14.08	1.09	2.0	9.717	2.699	860	0.388	5.025	241.0	242.2	0.917

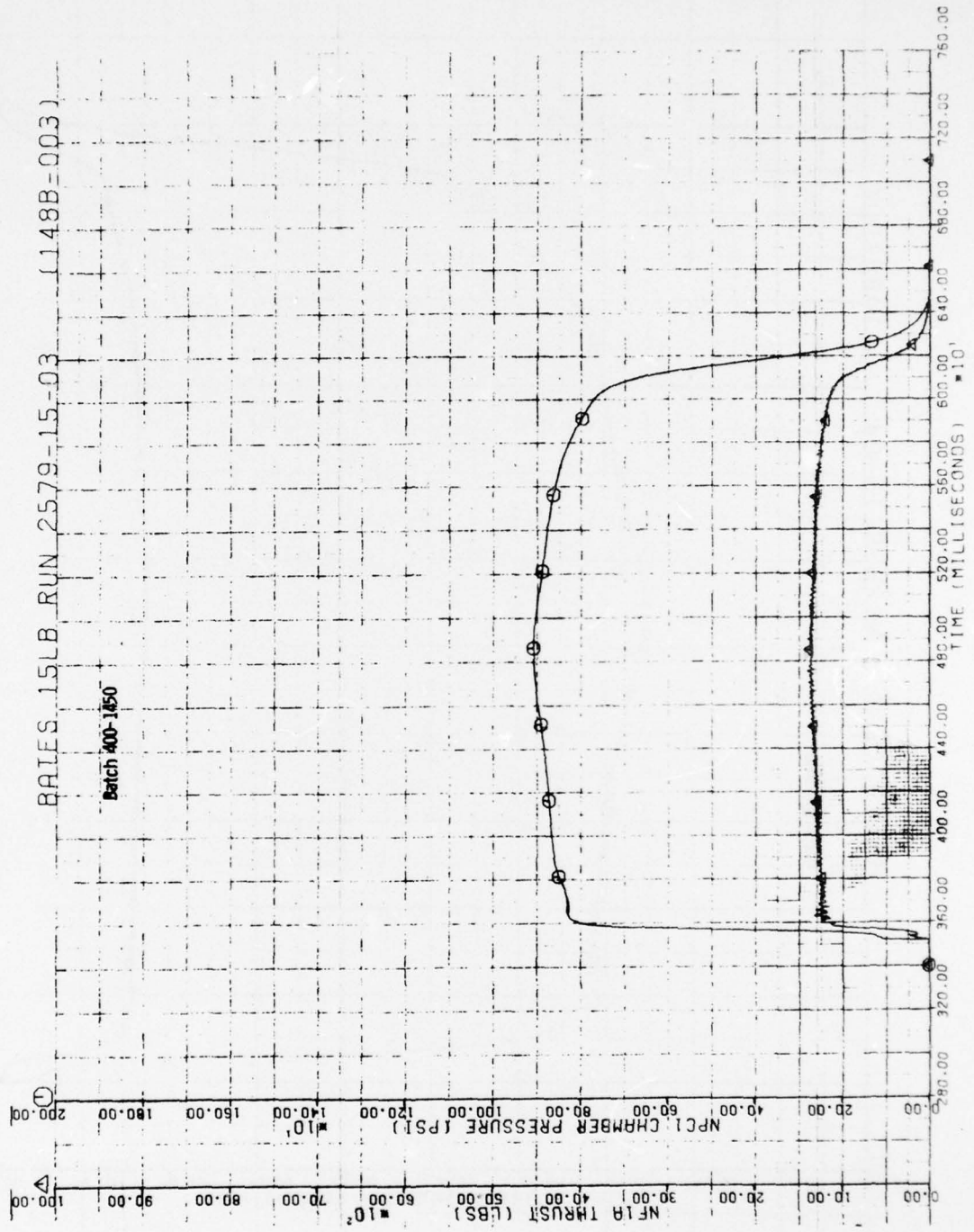
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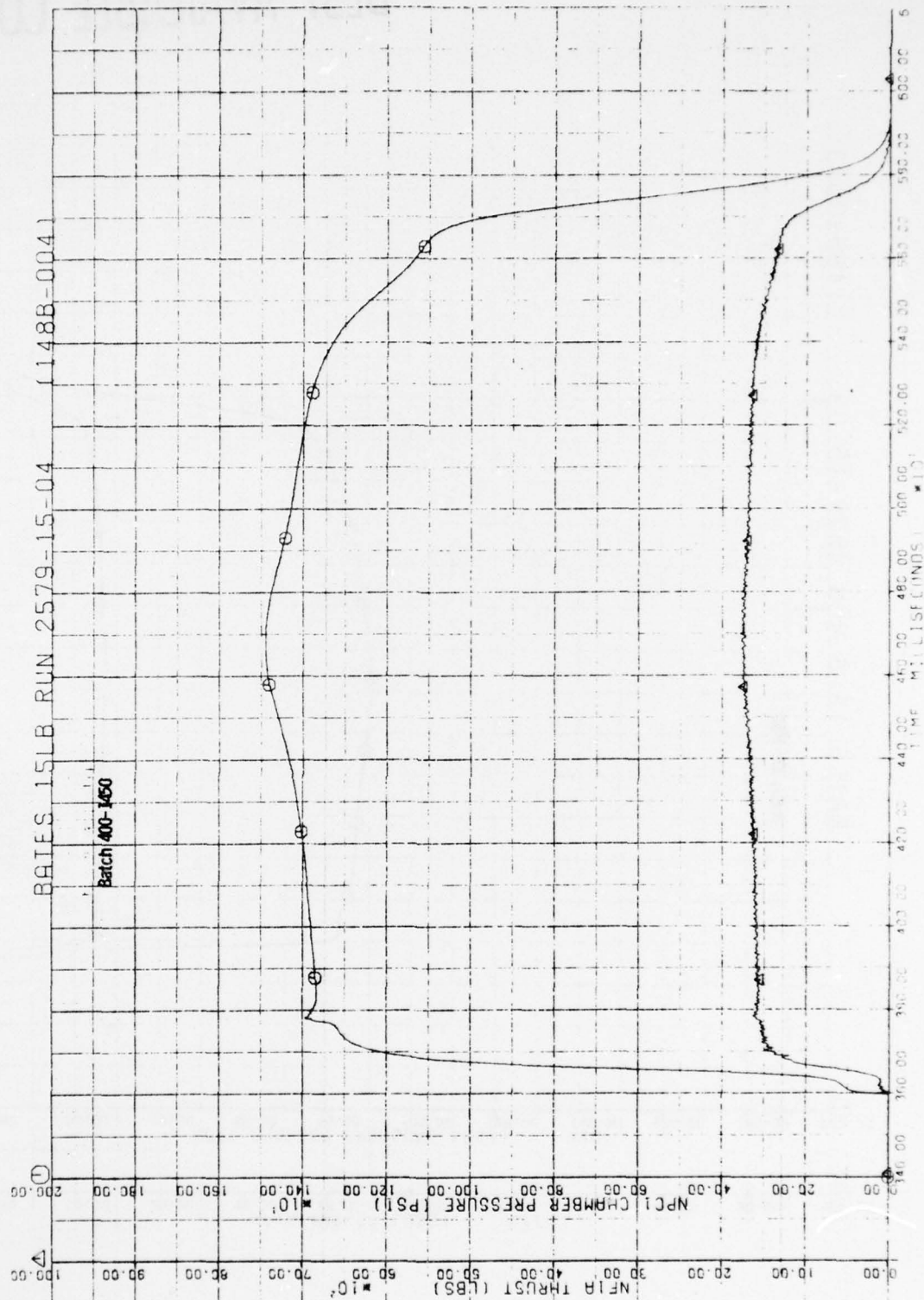


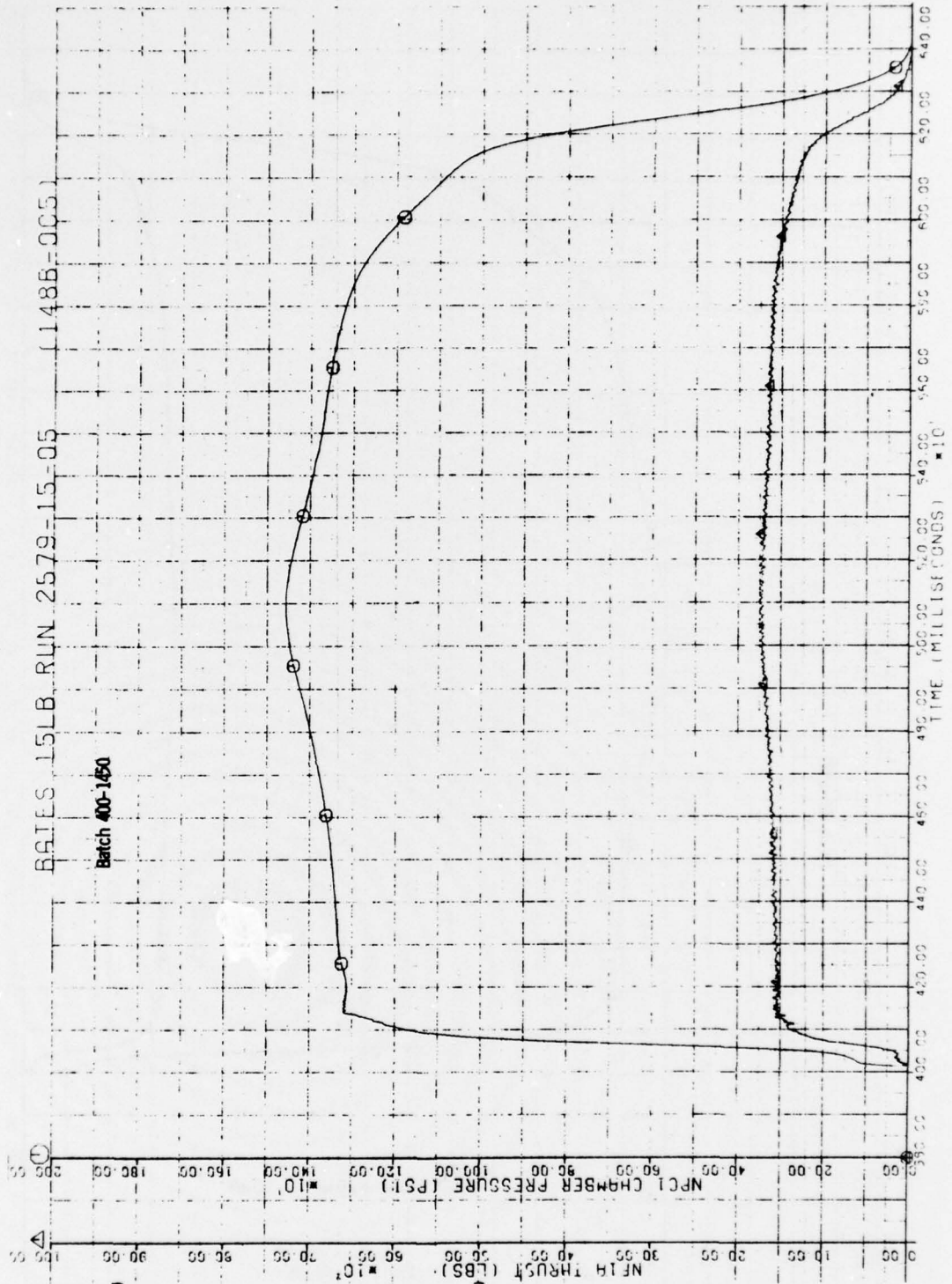
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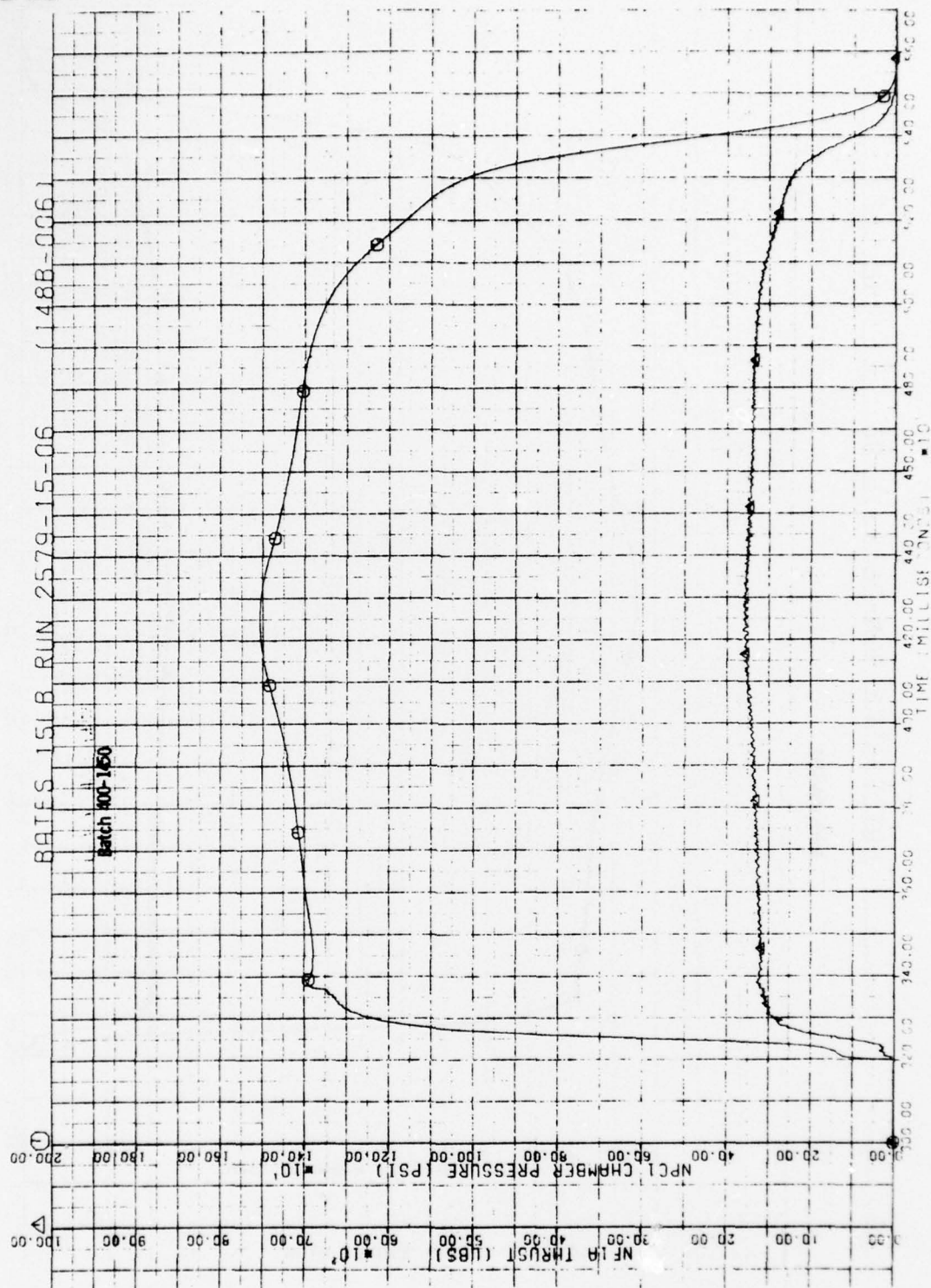


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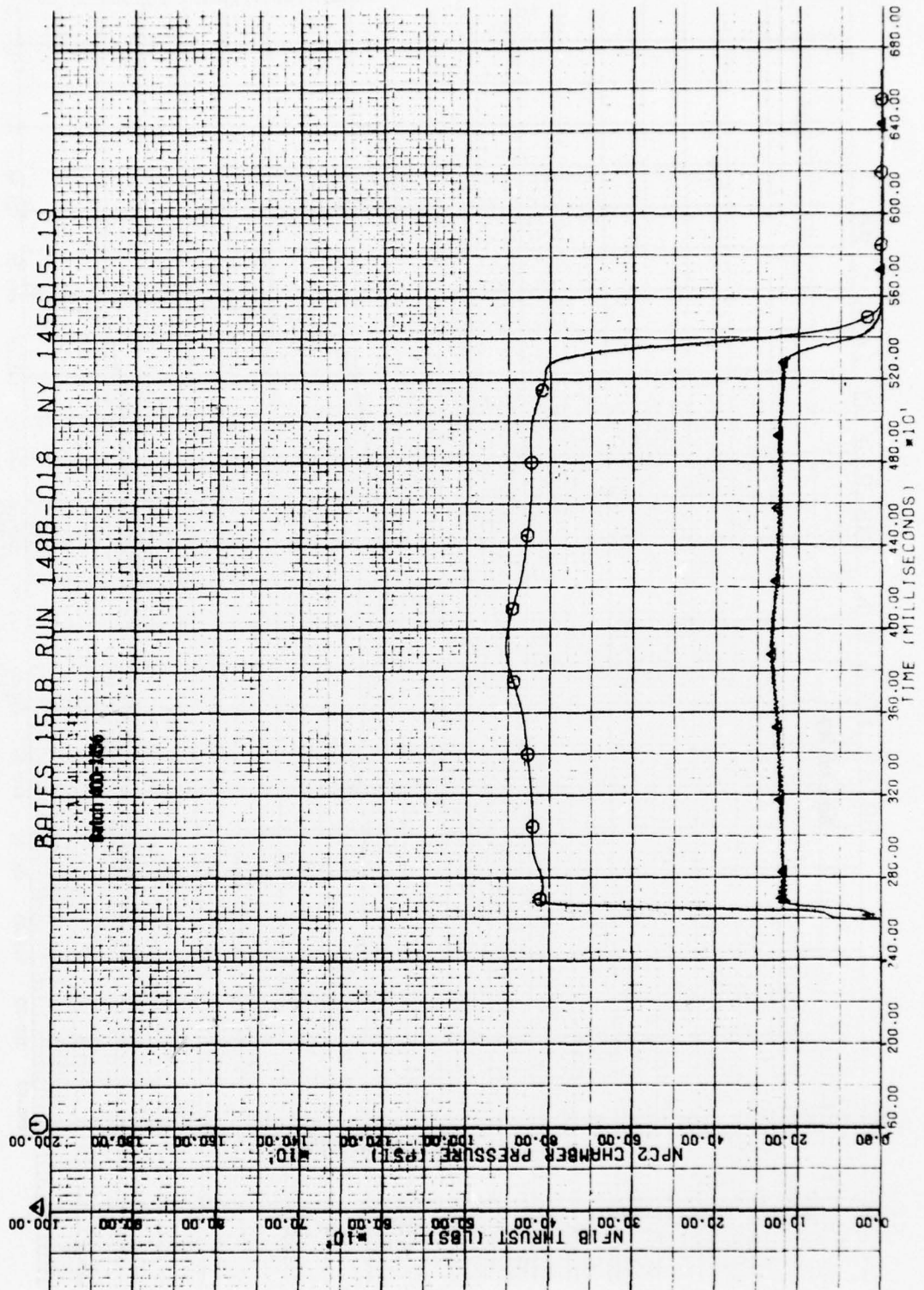




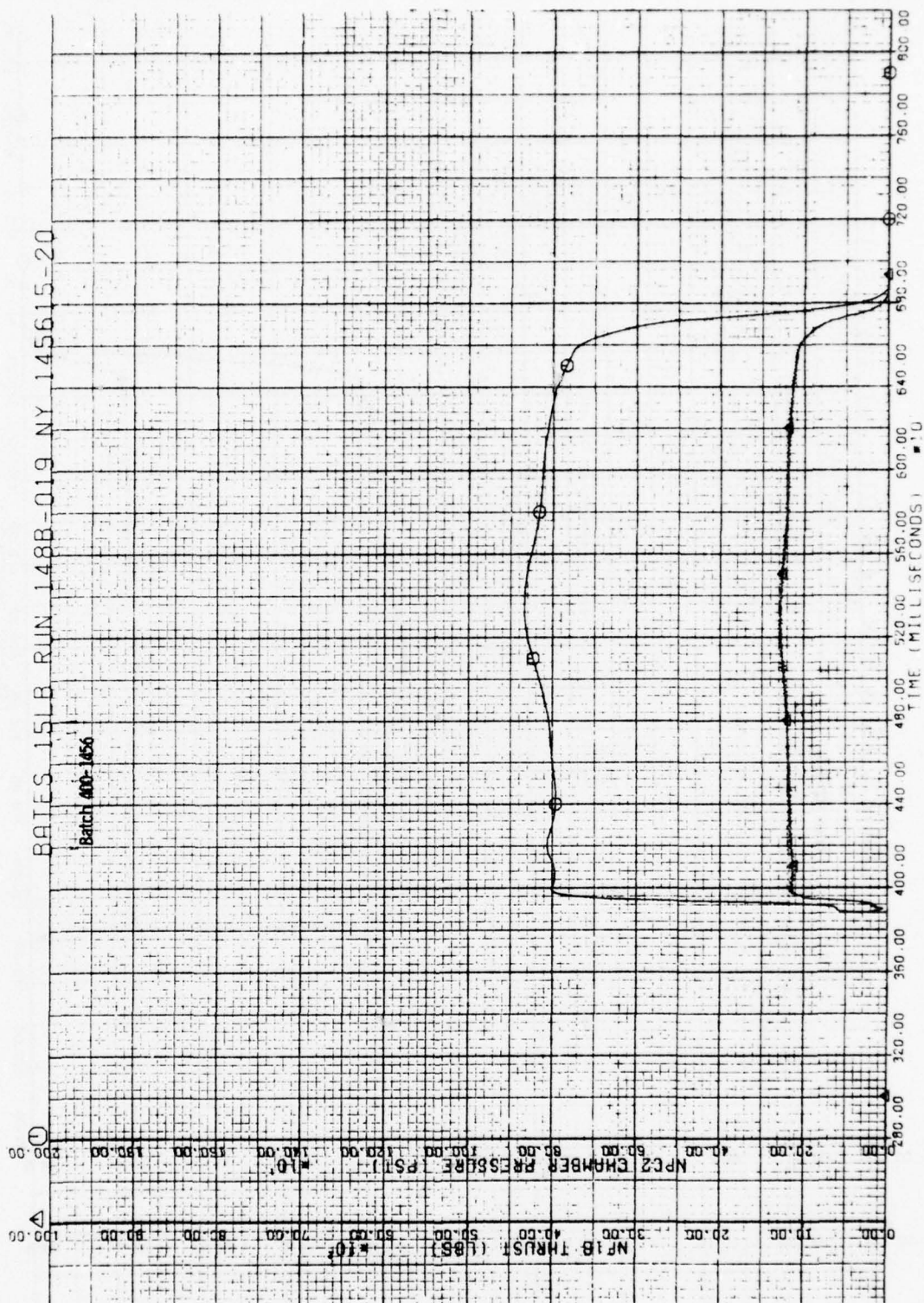
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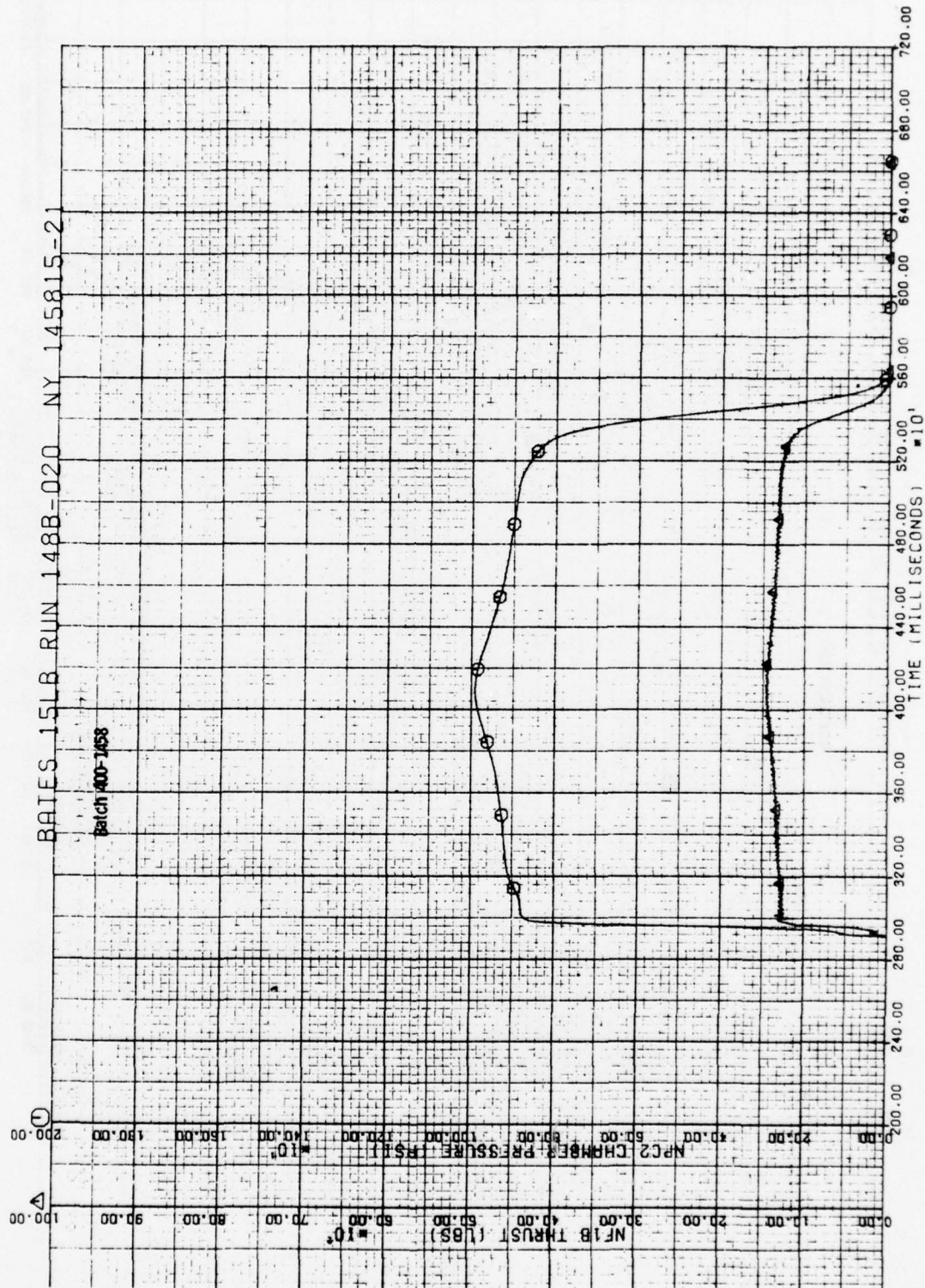
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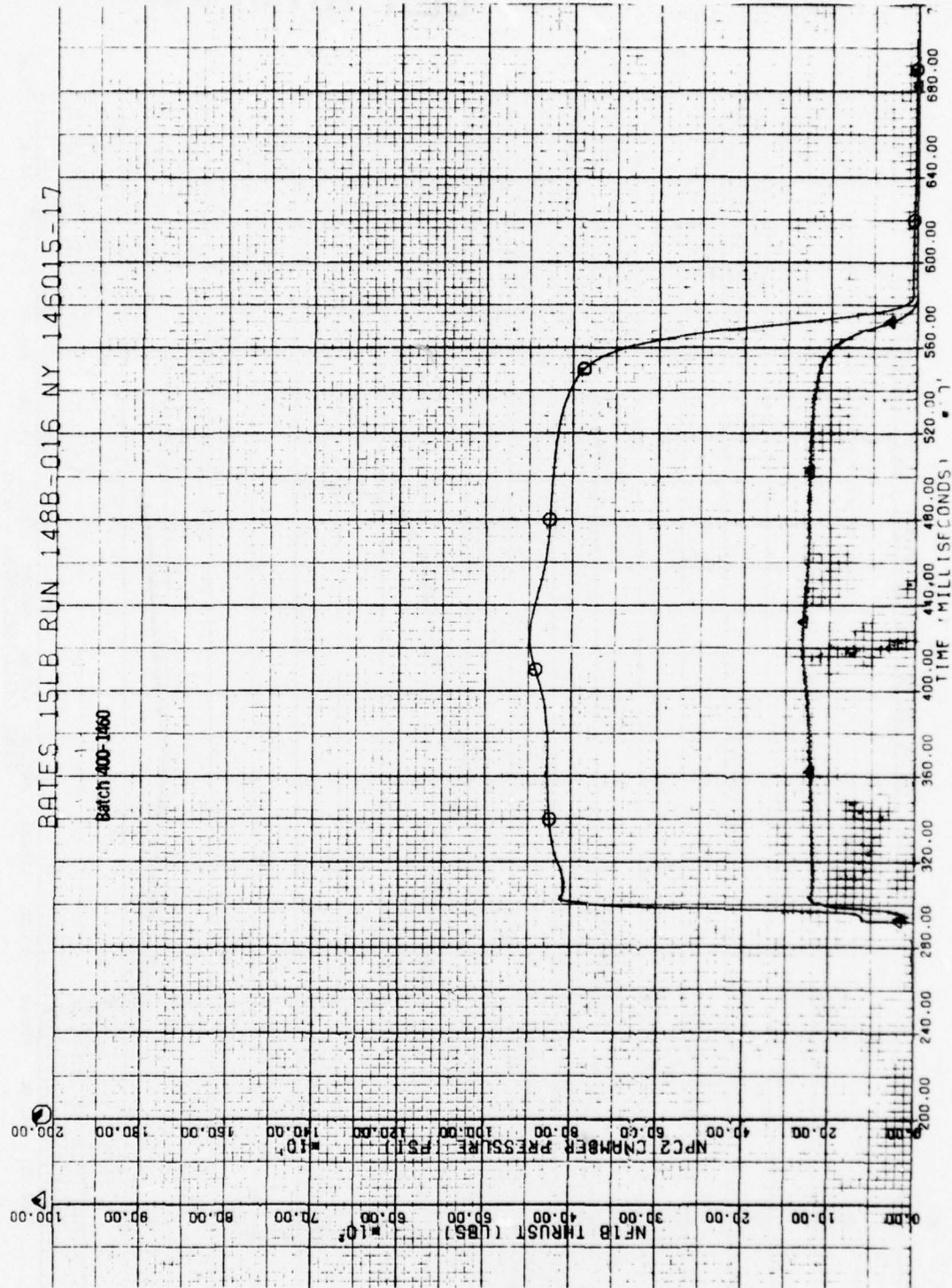


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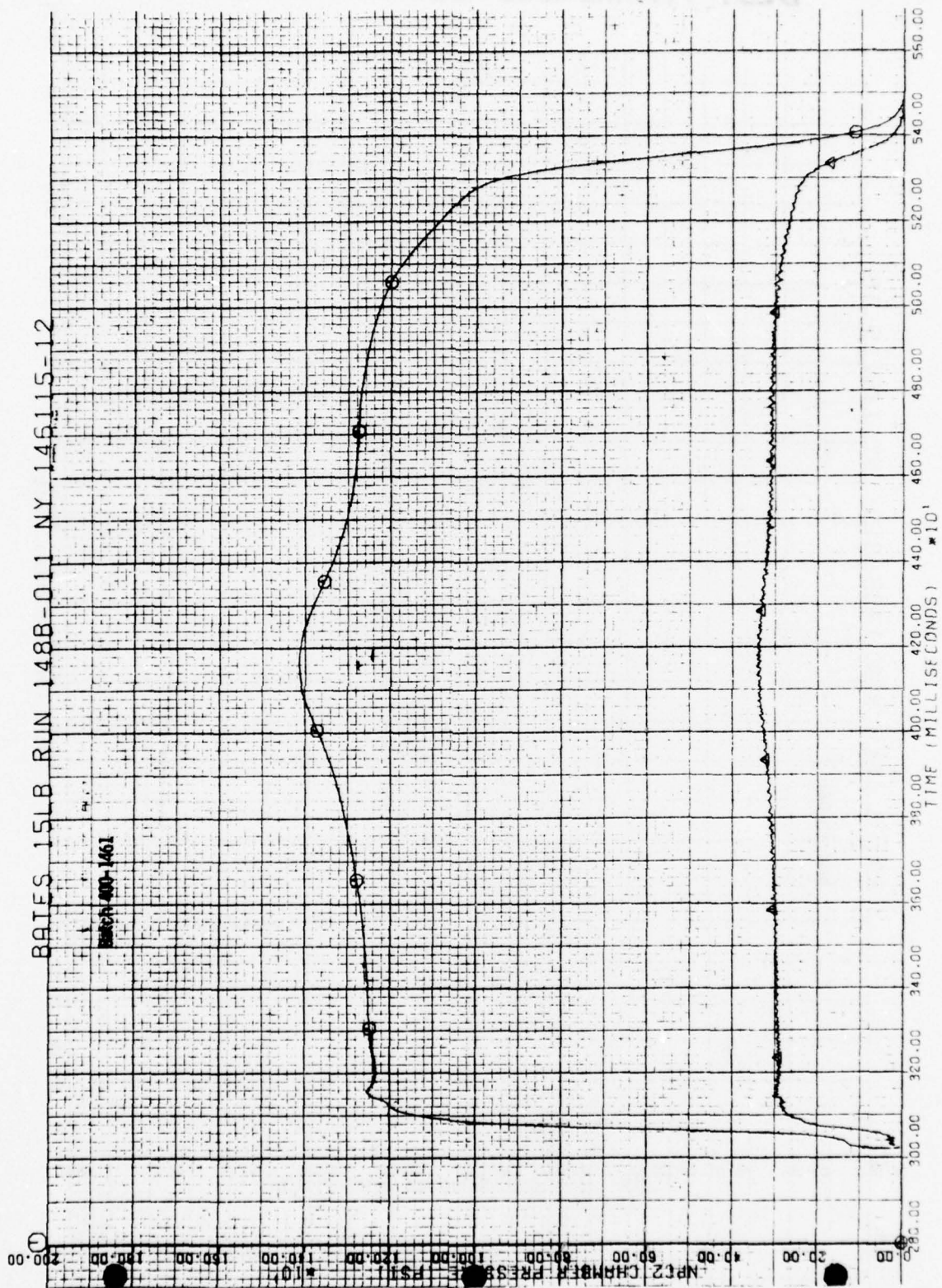


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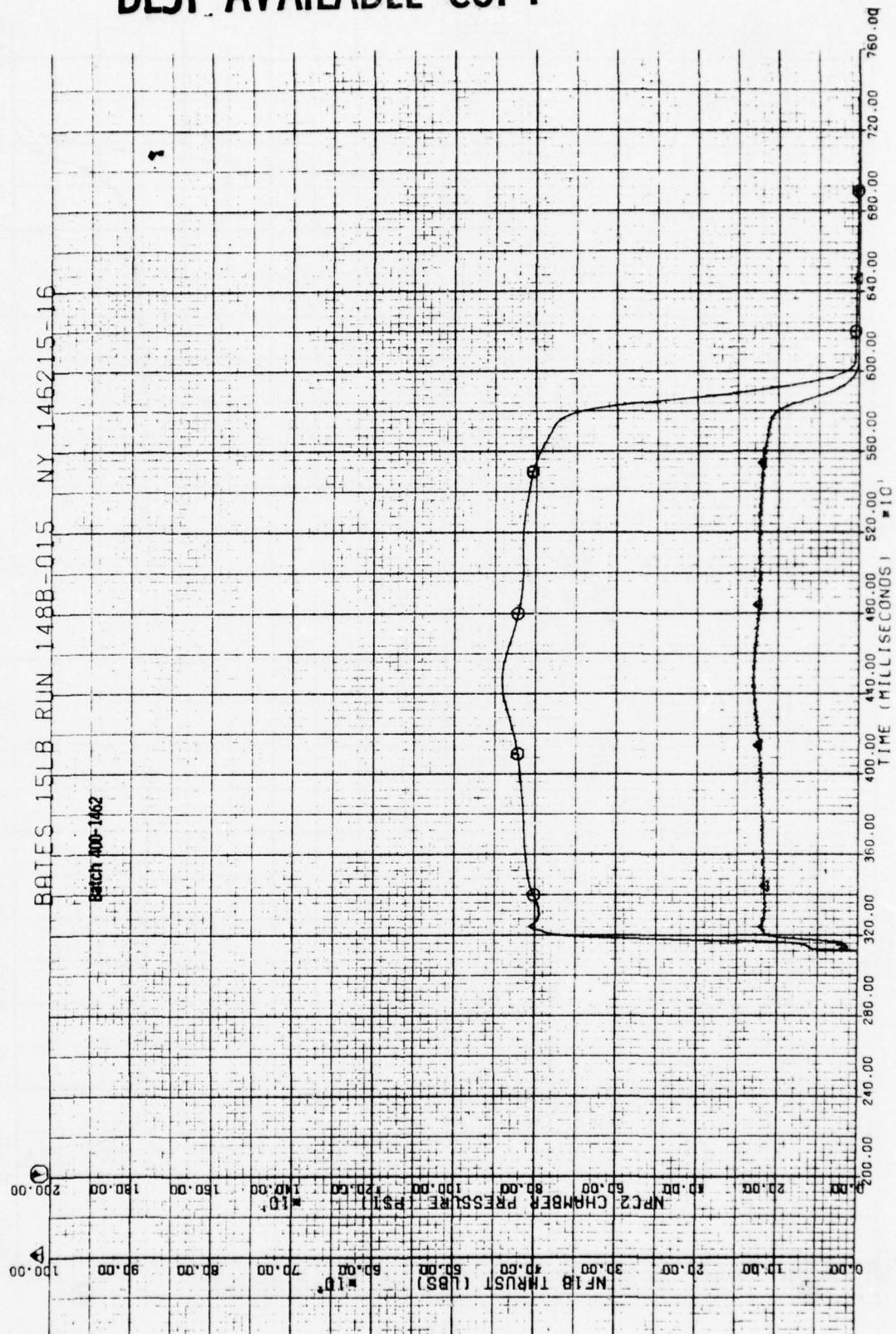




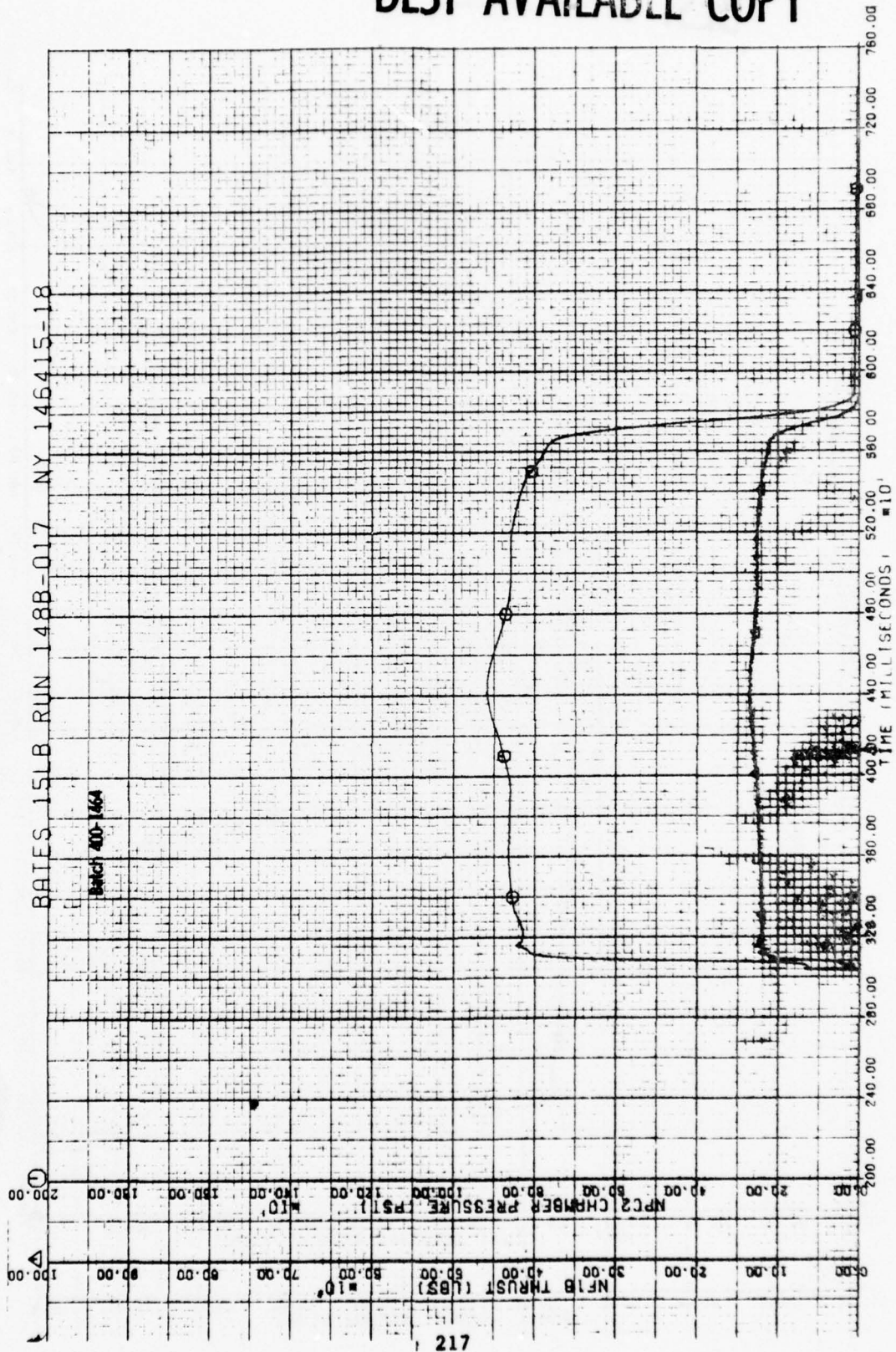
215



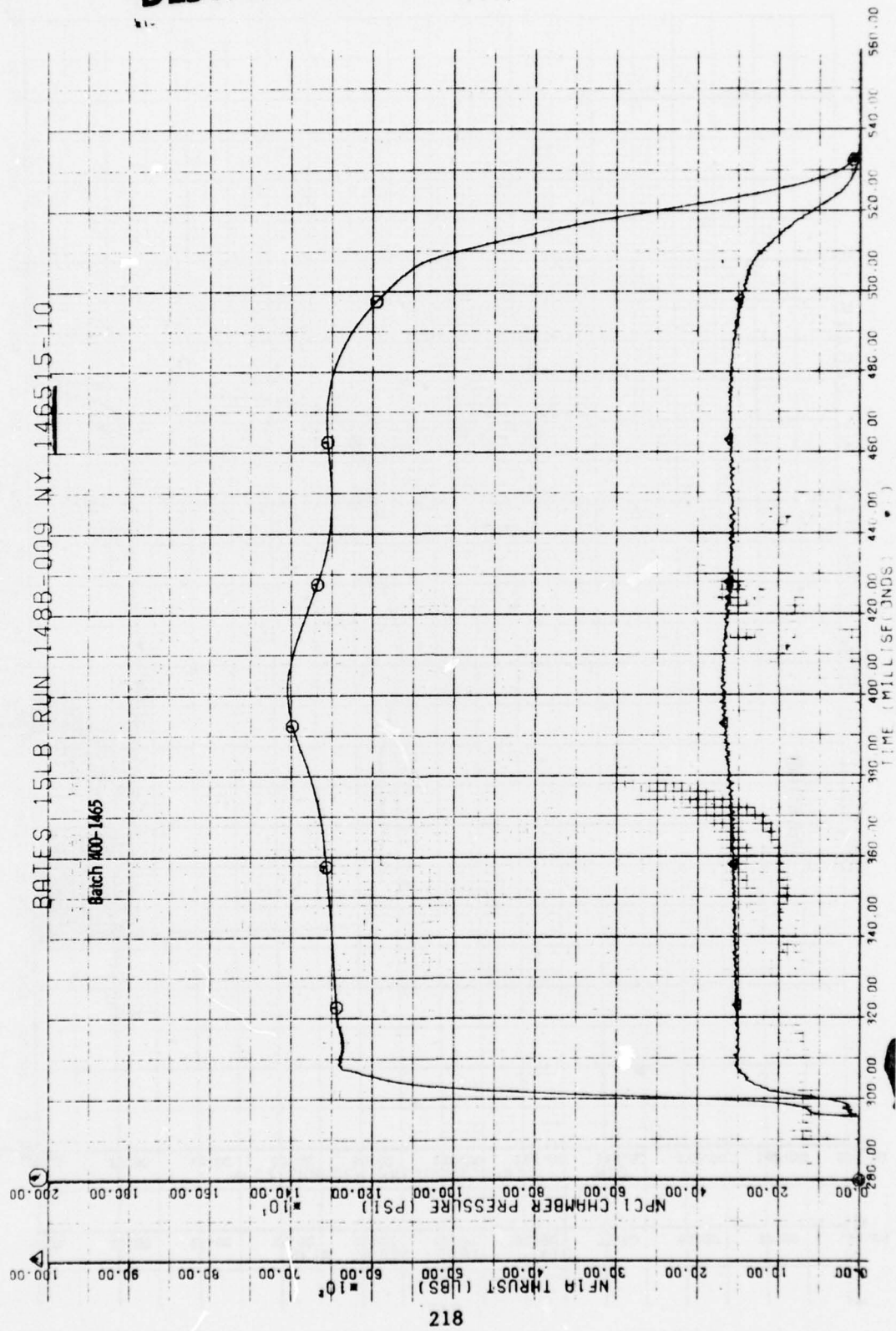
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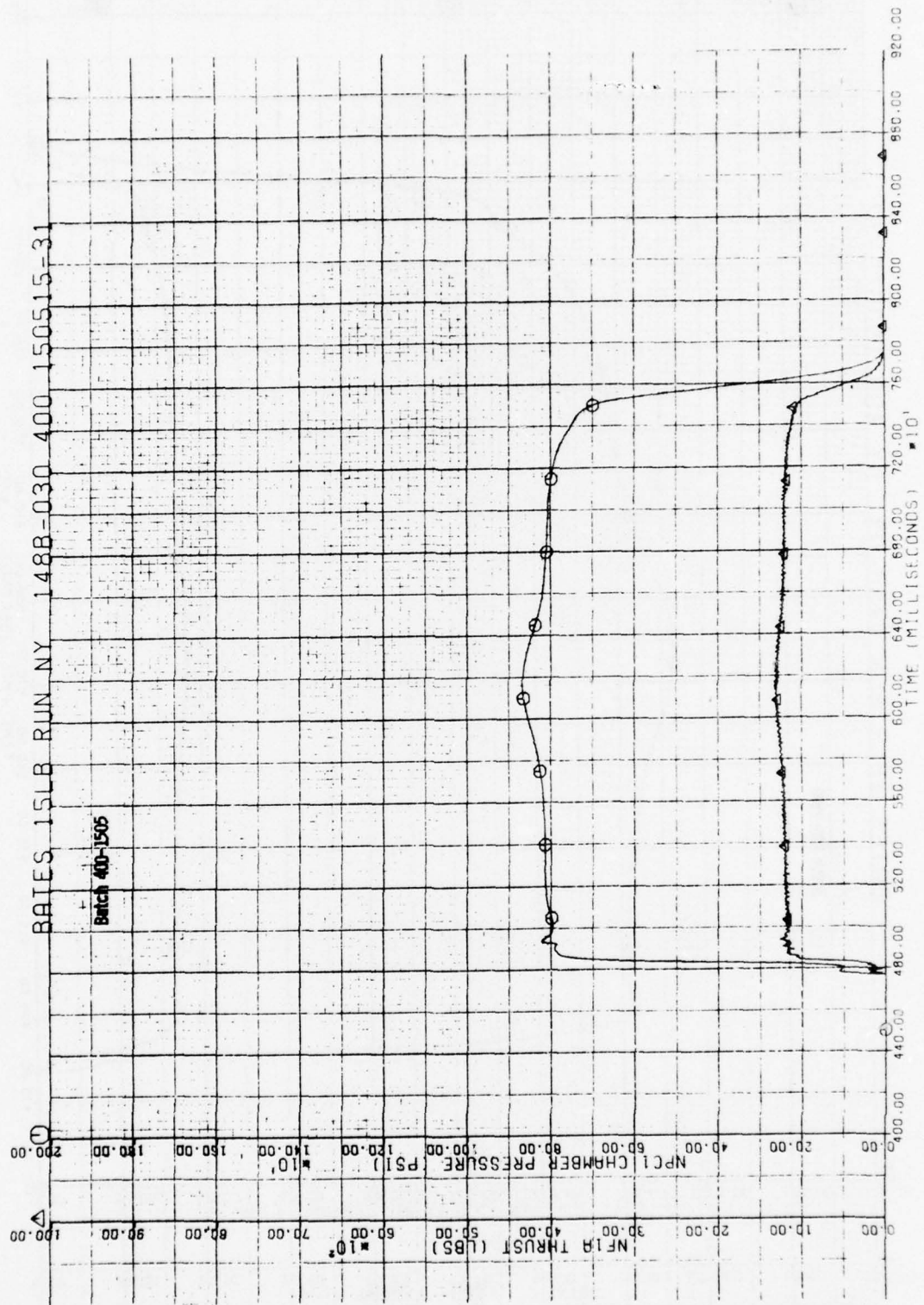
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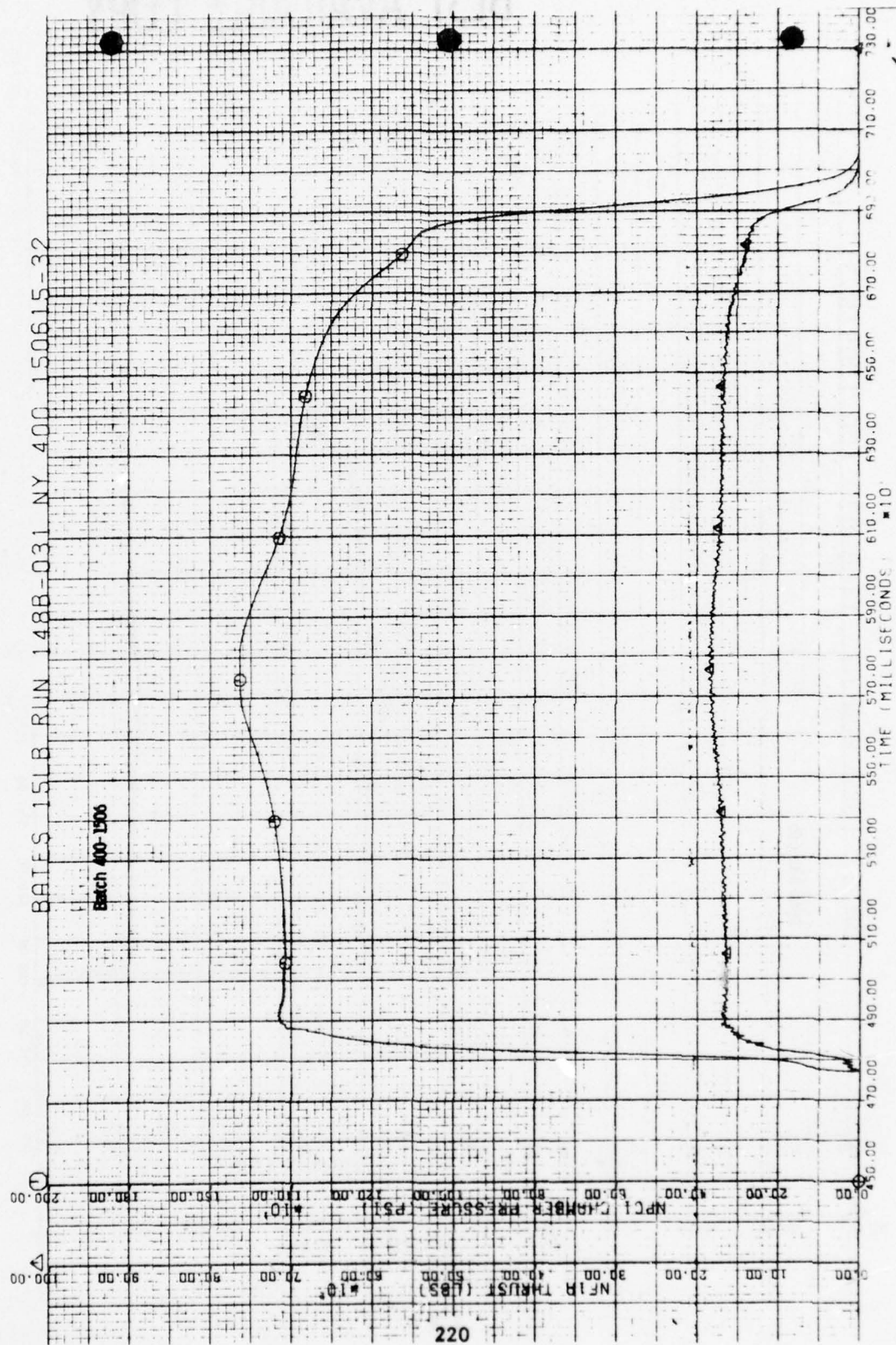
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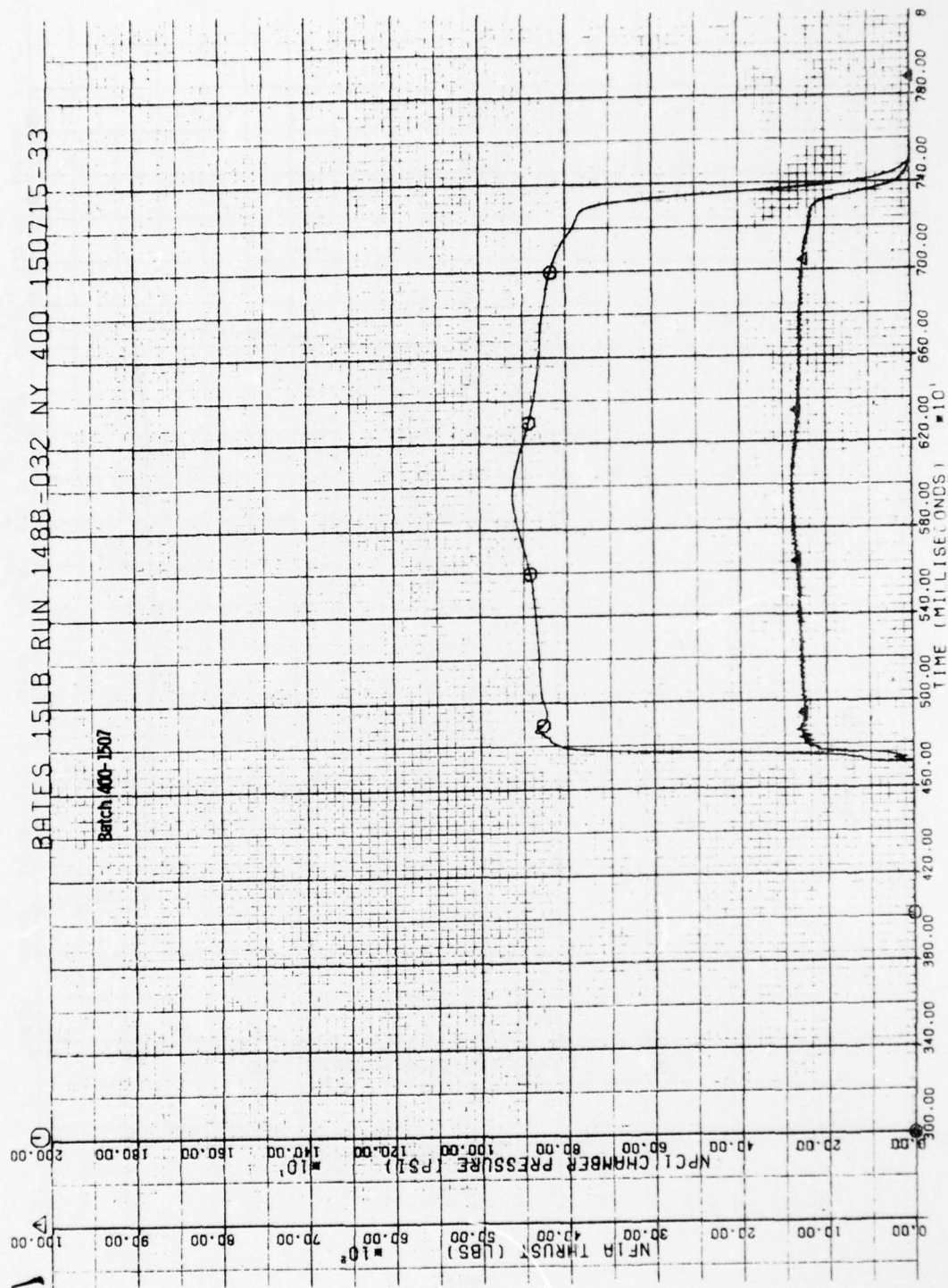
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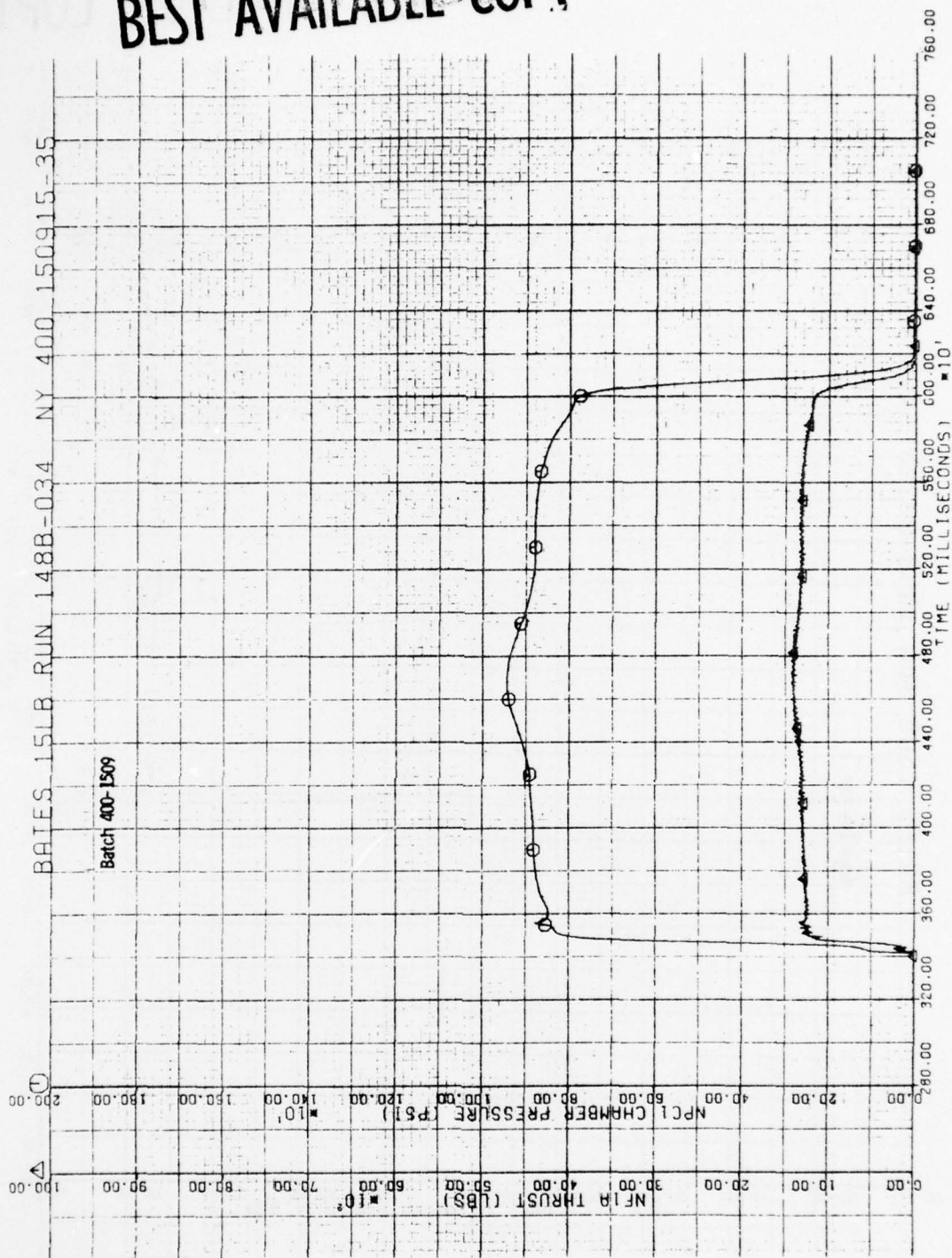
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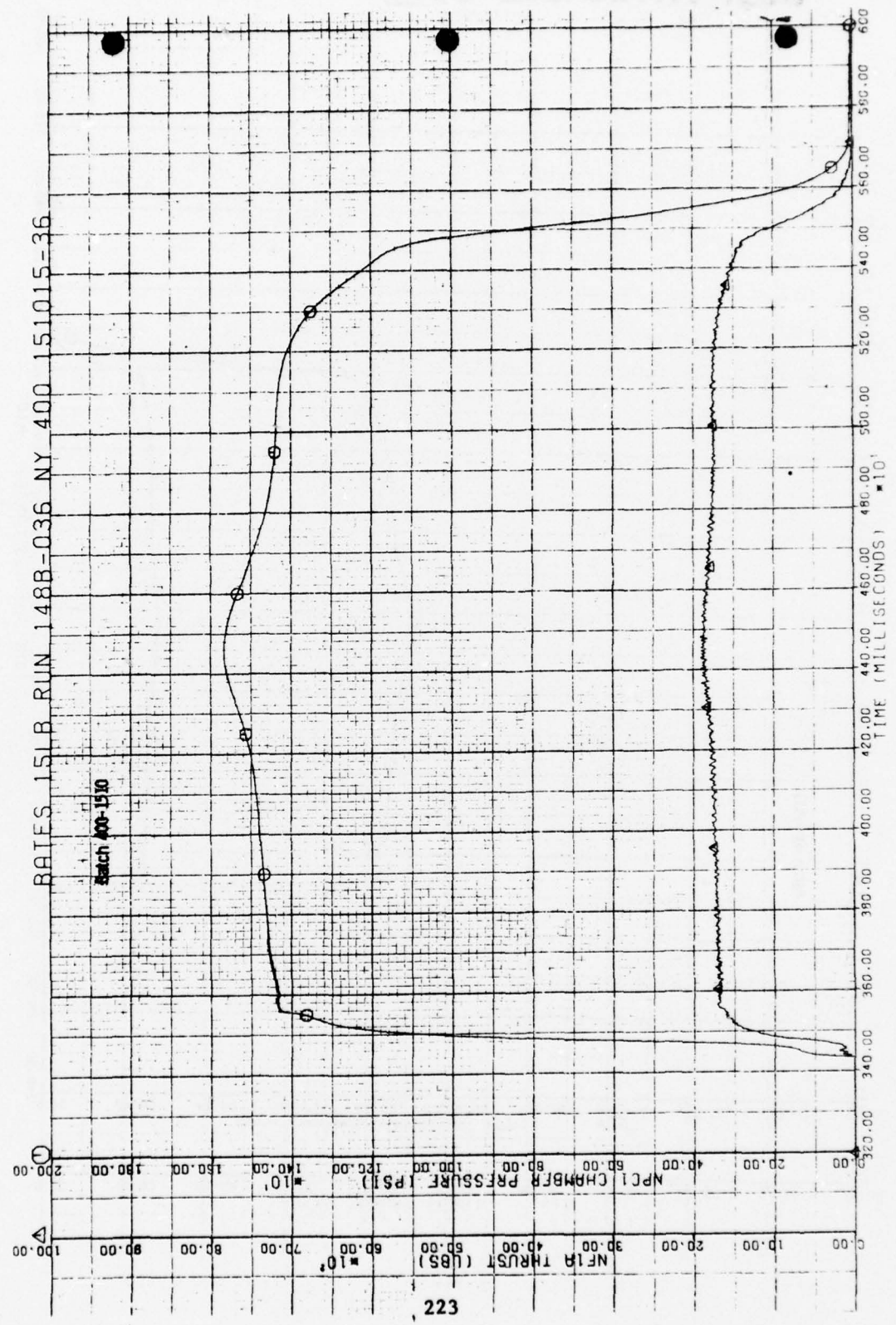
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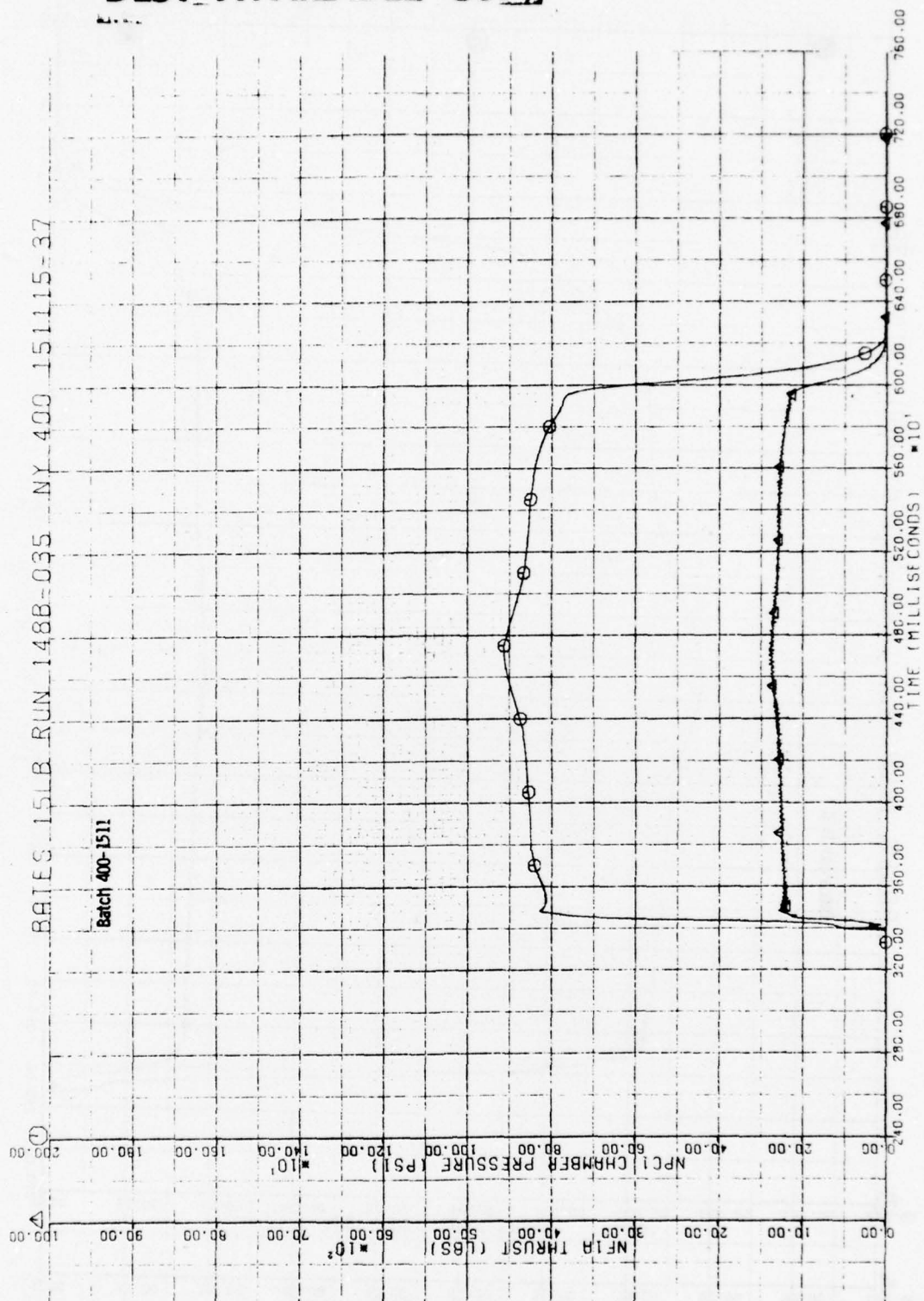
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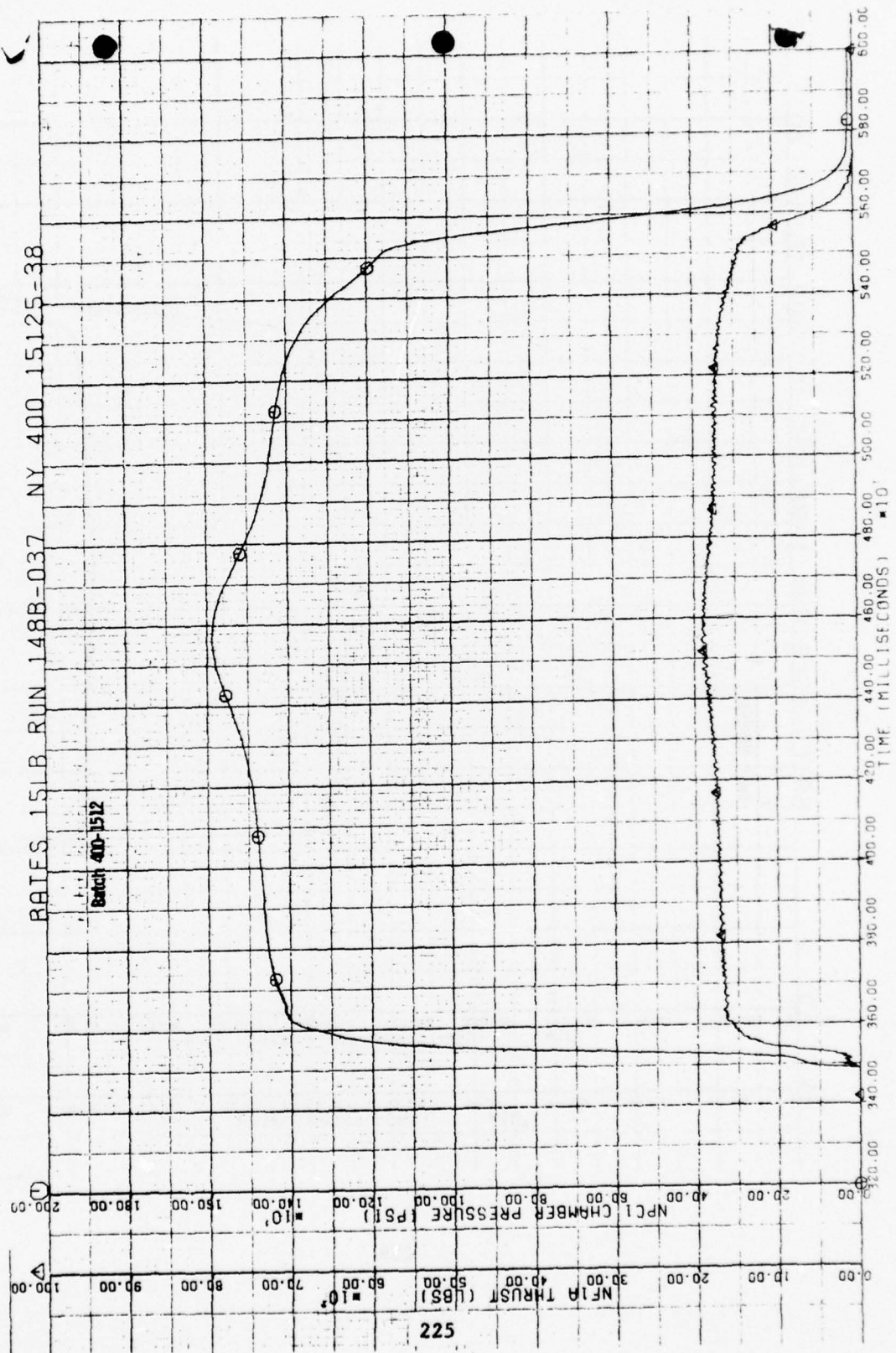
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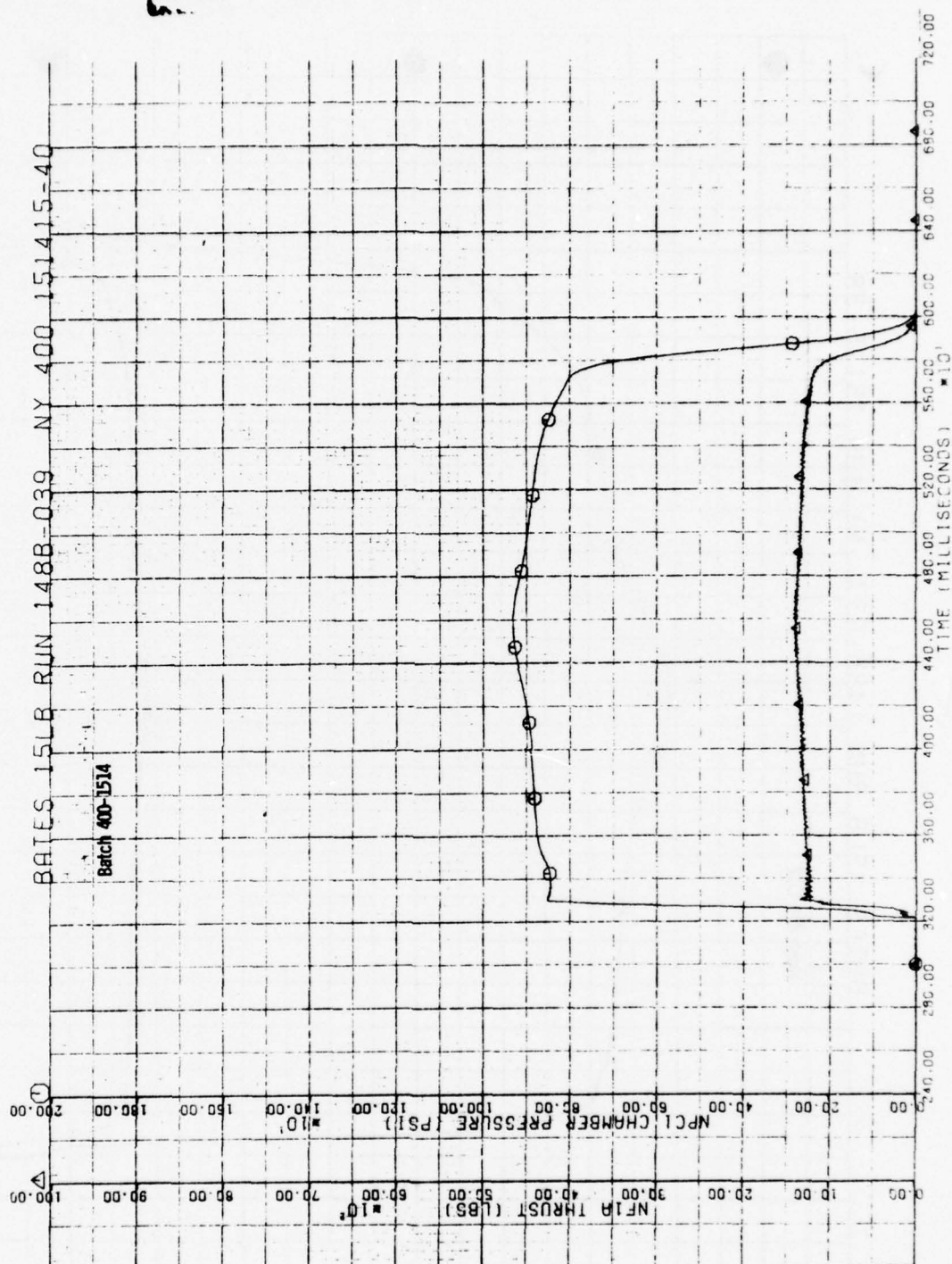
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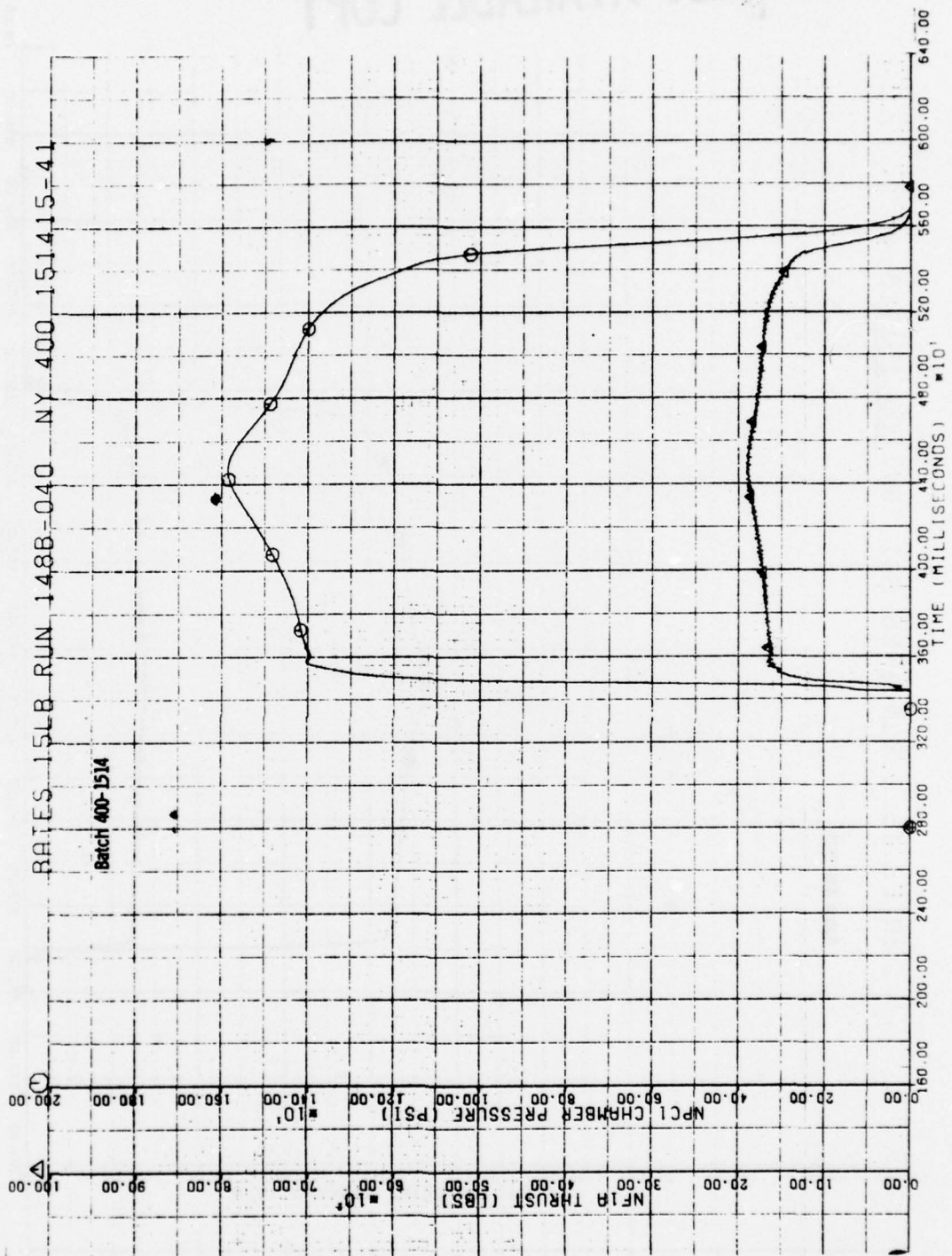
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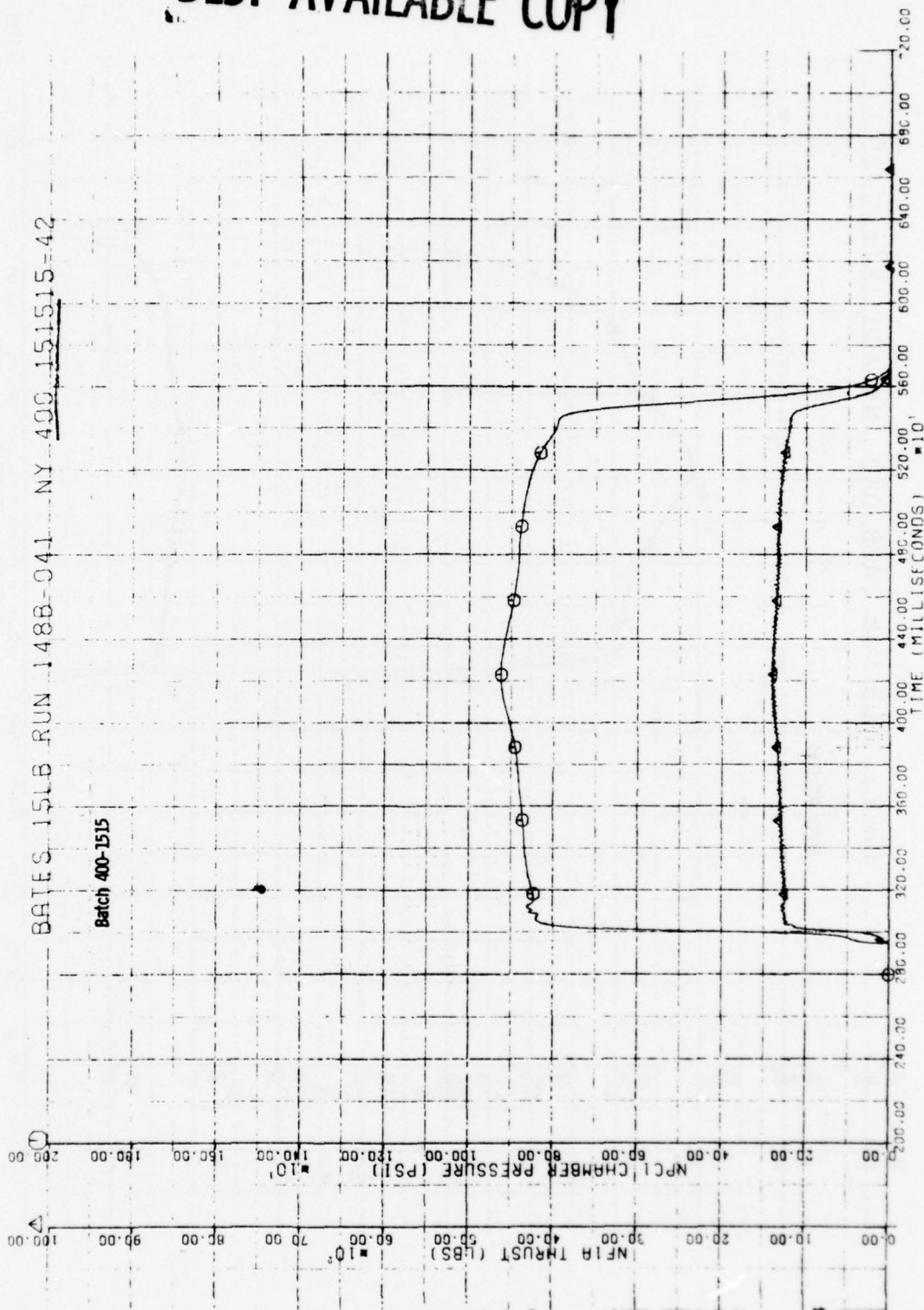
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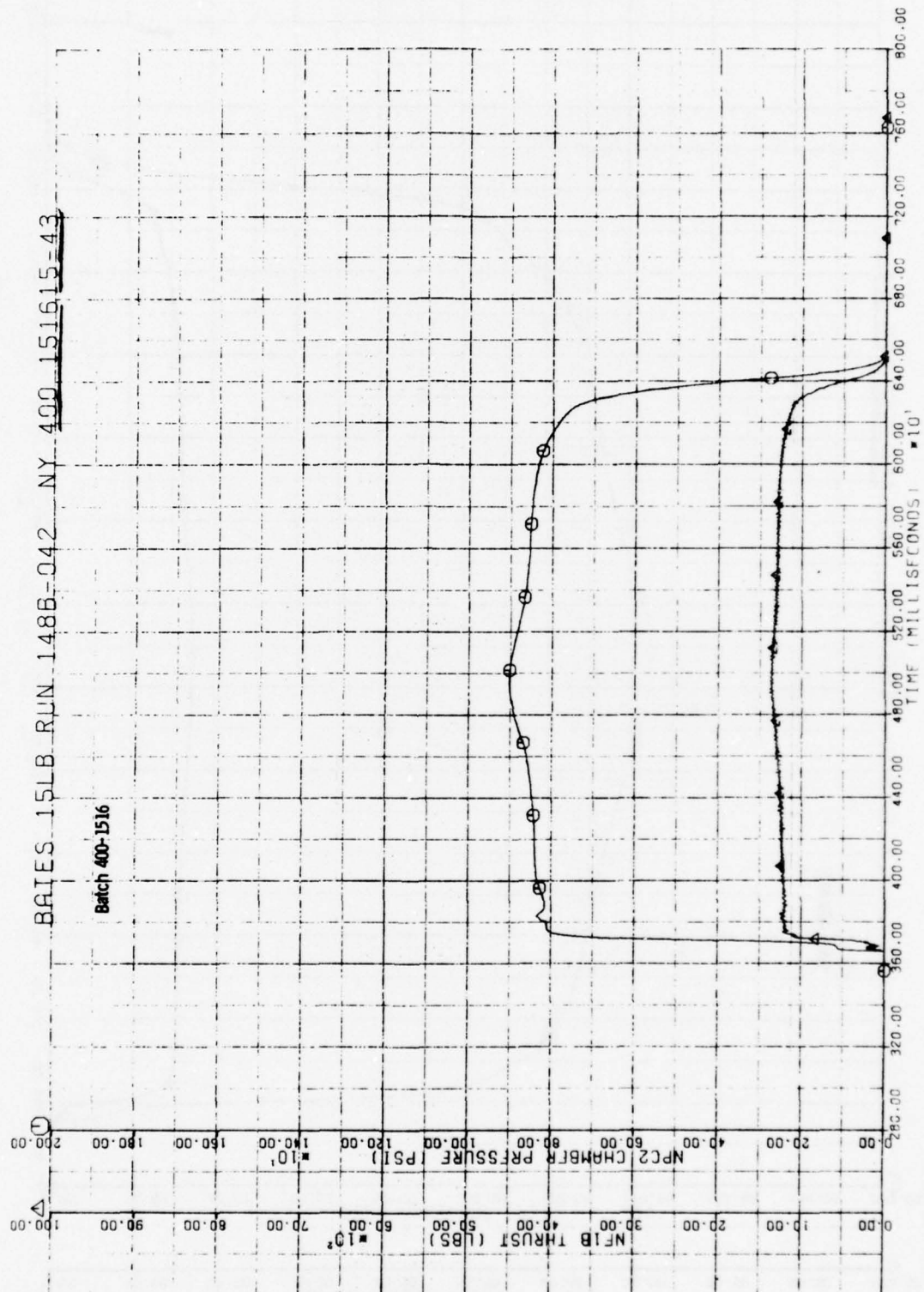
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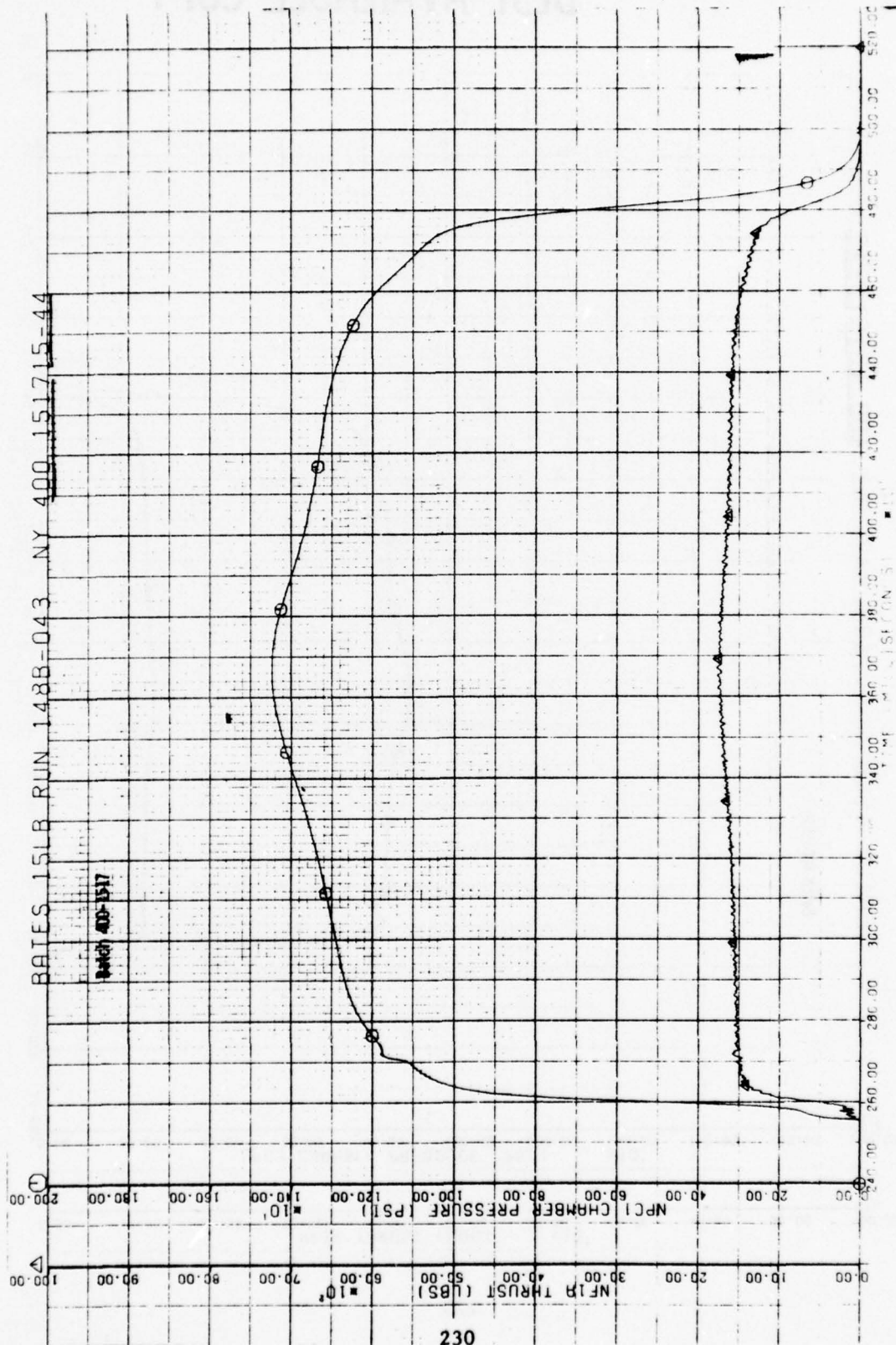
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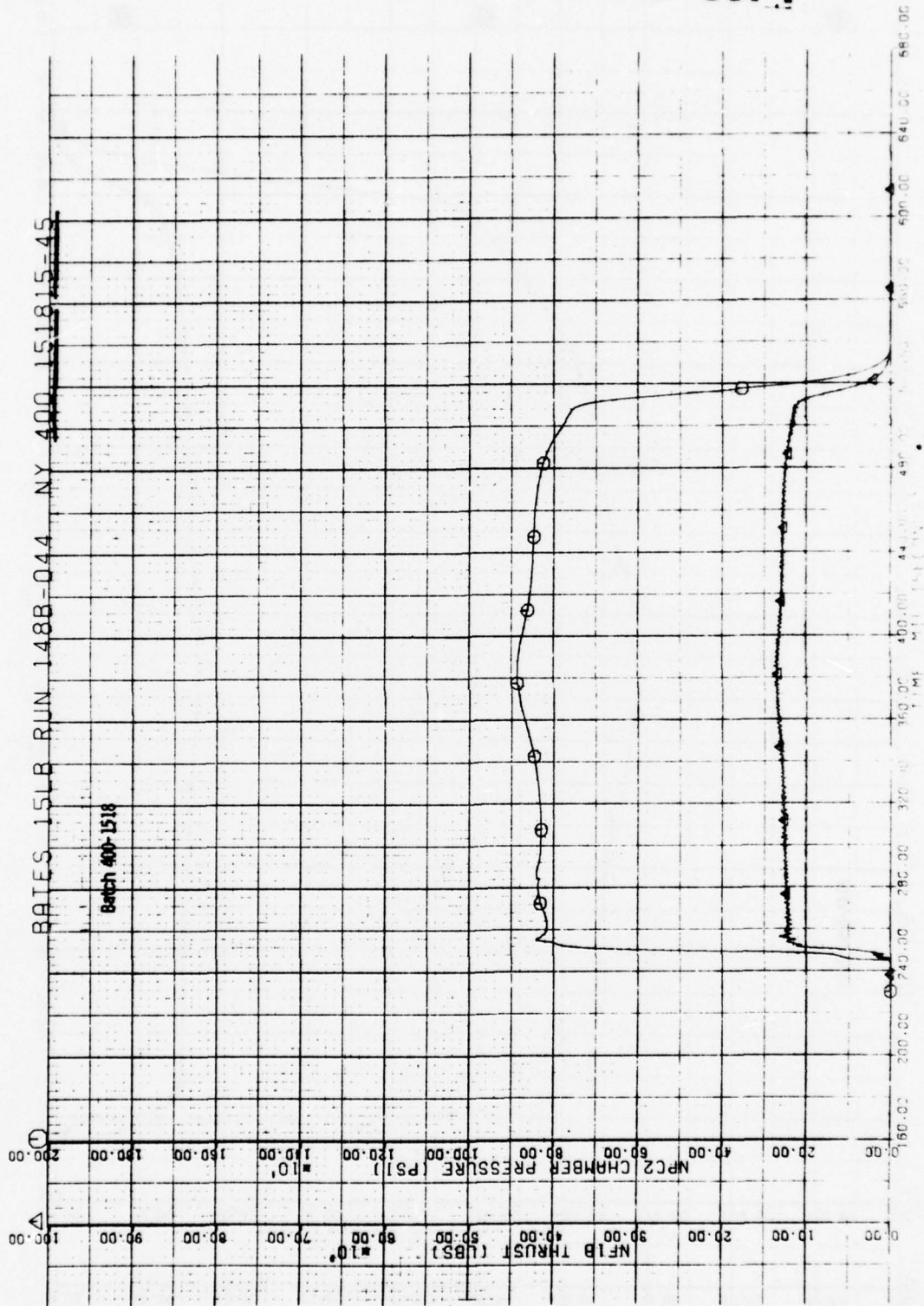
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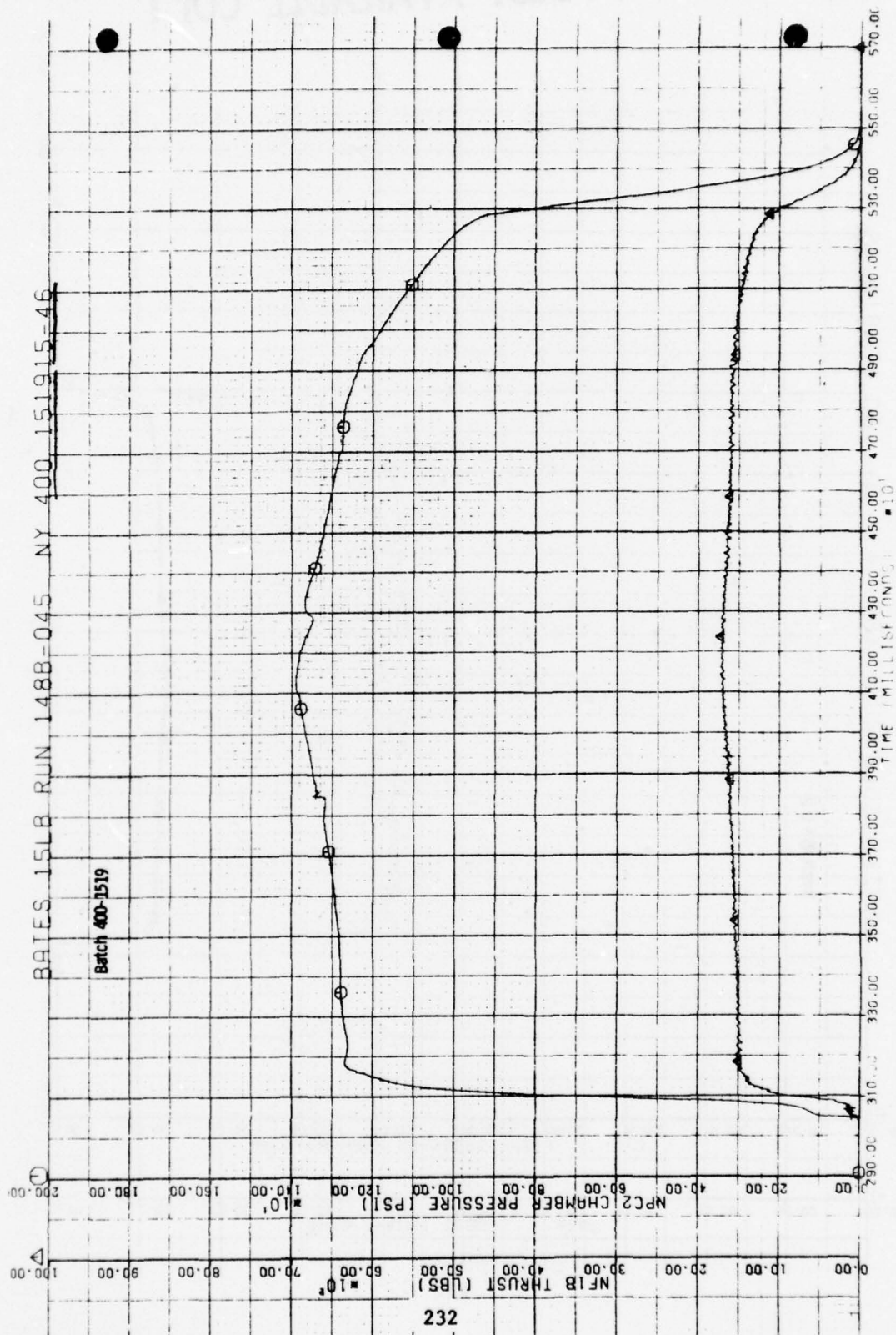
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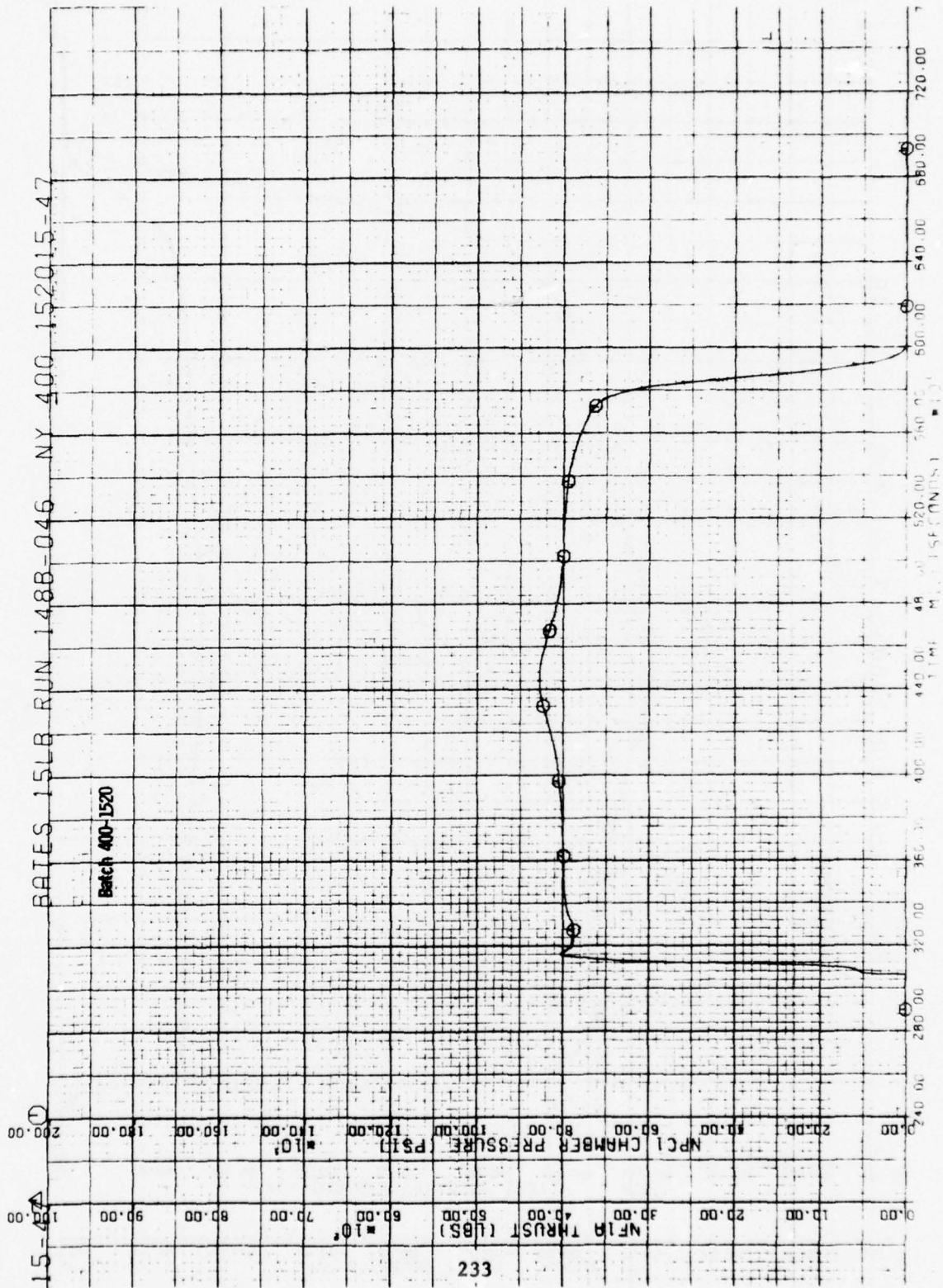
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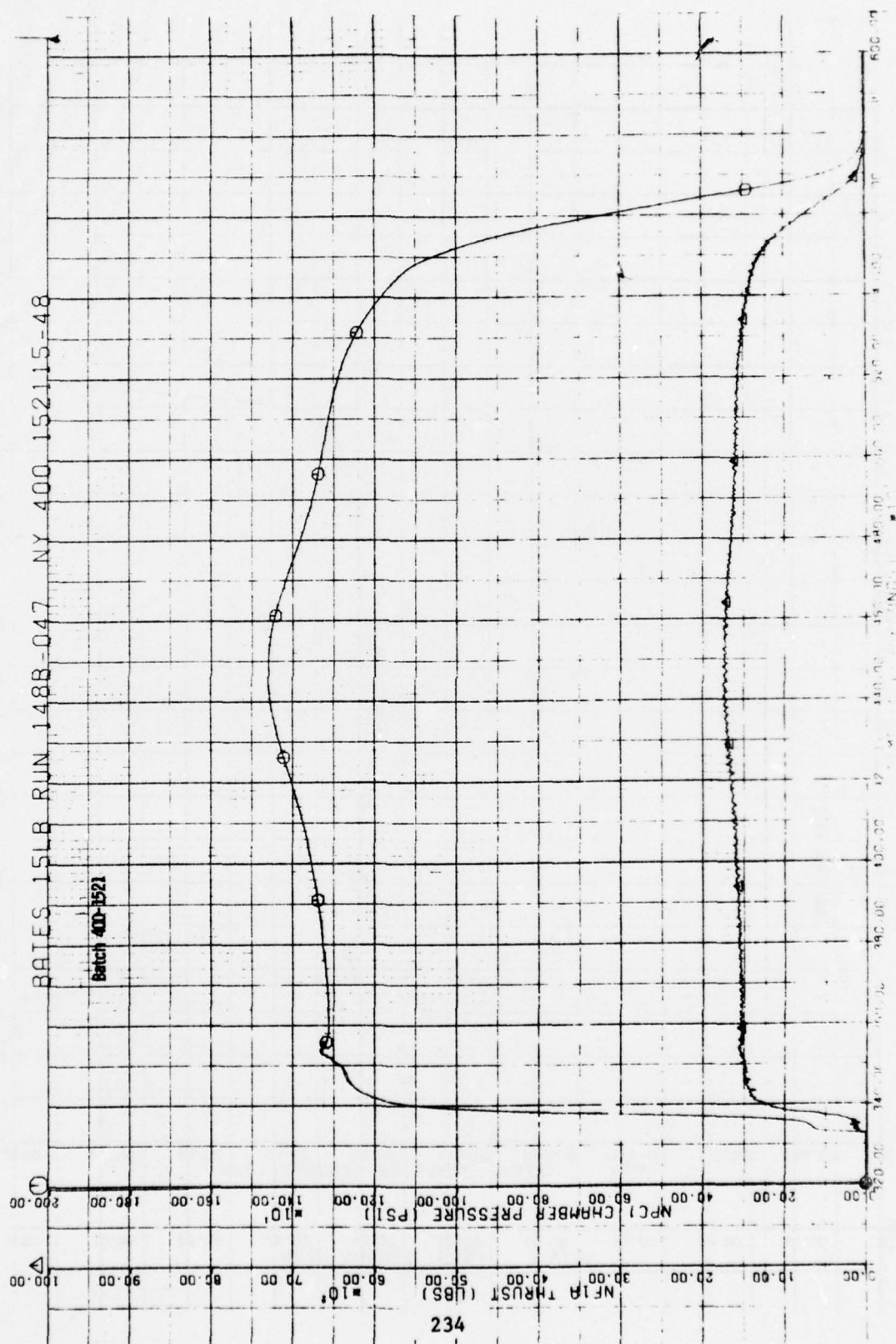
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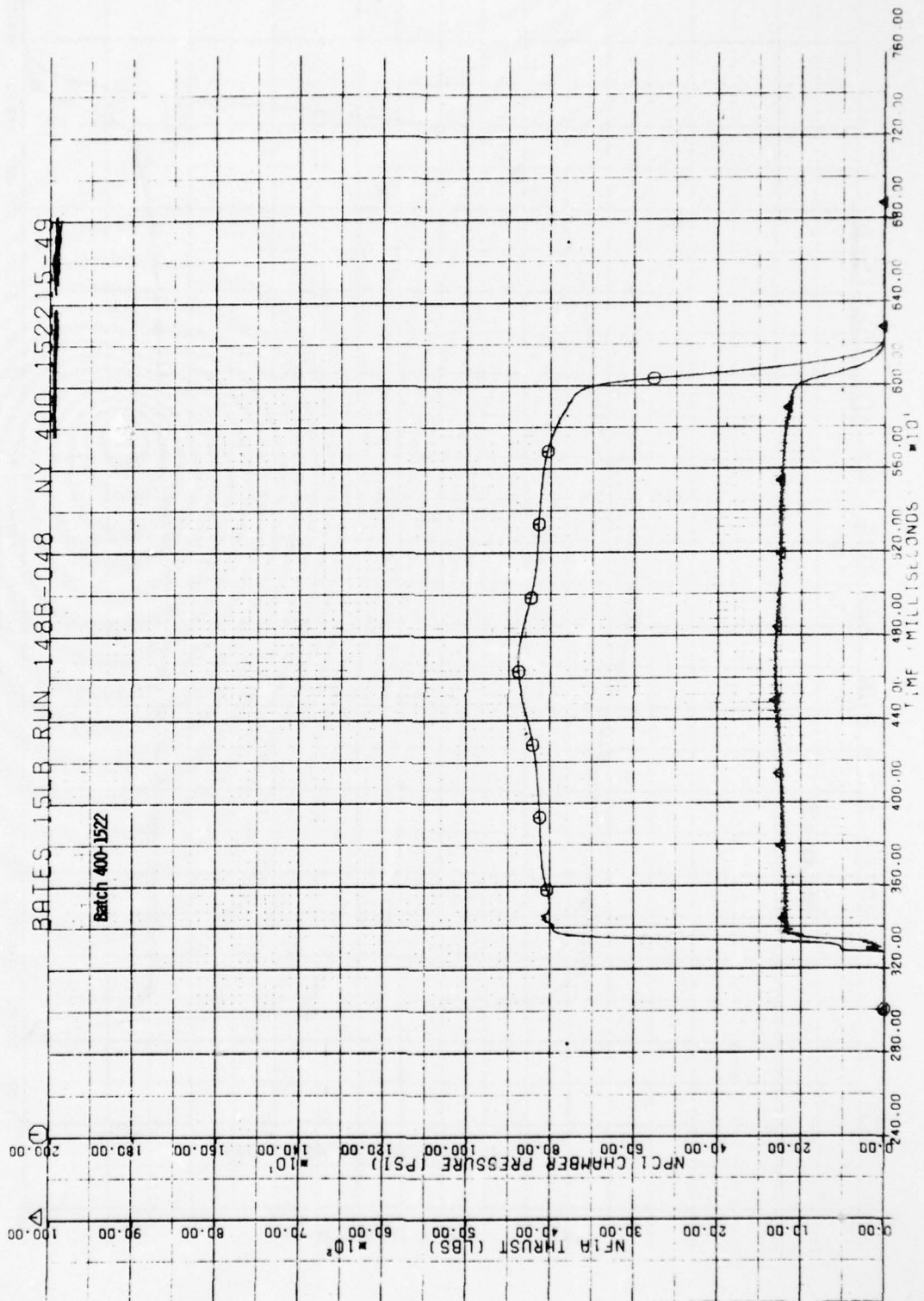
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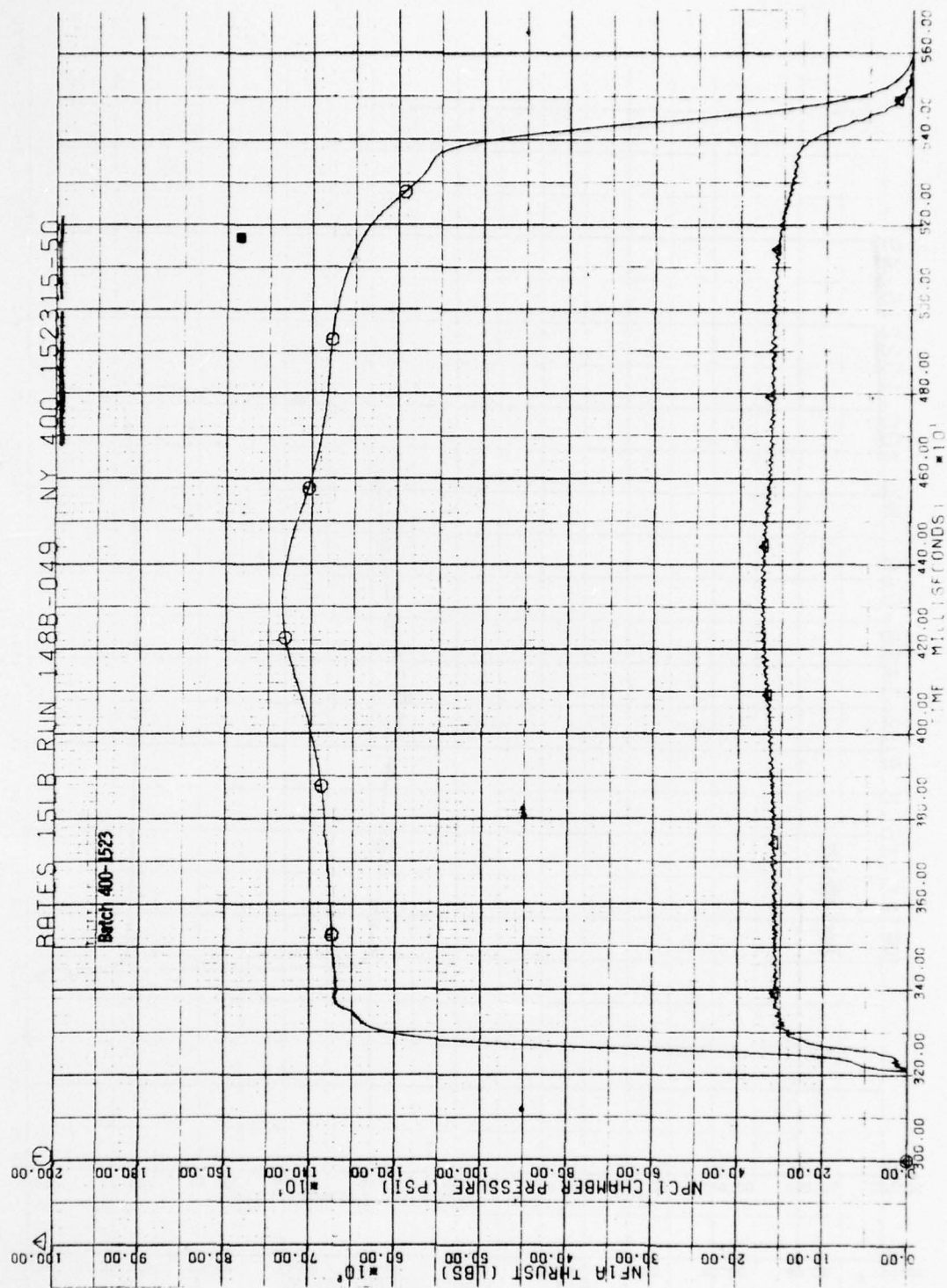
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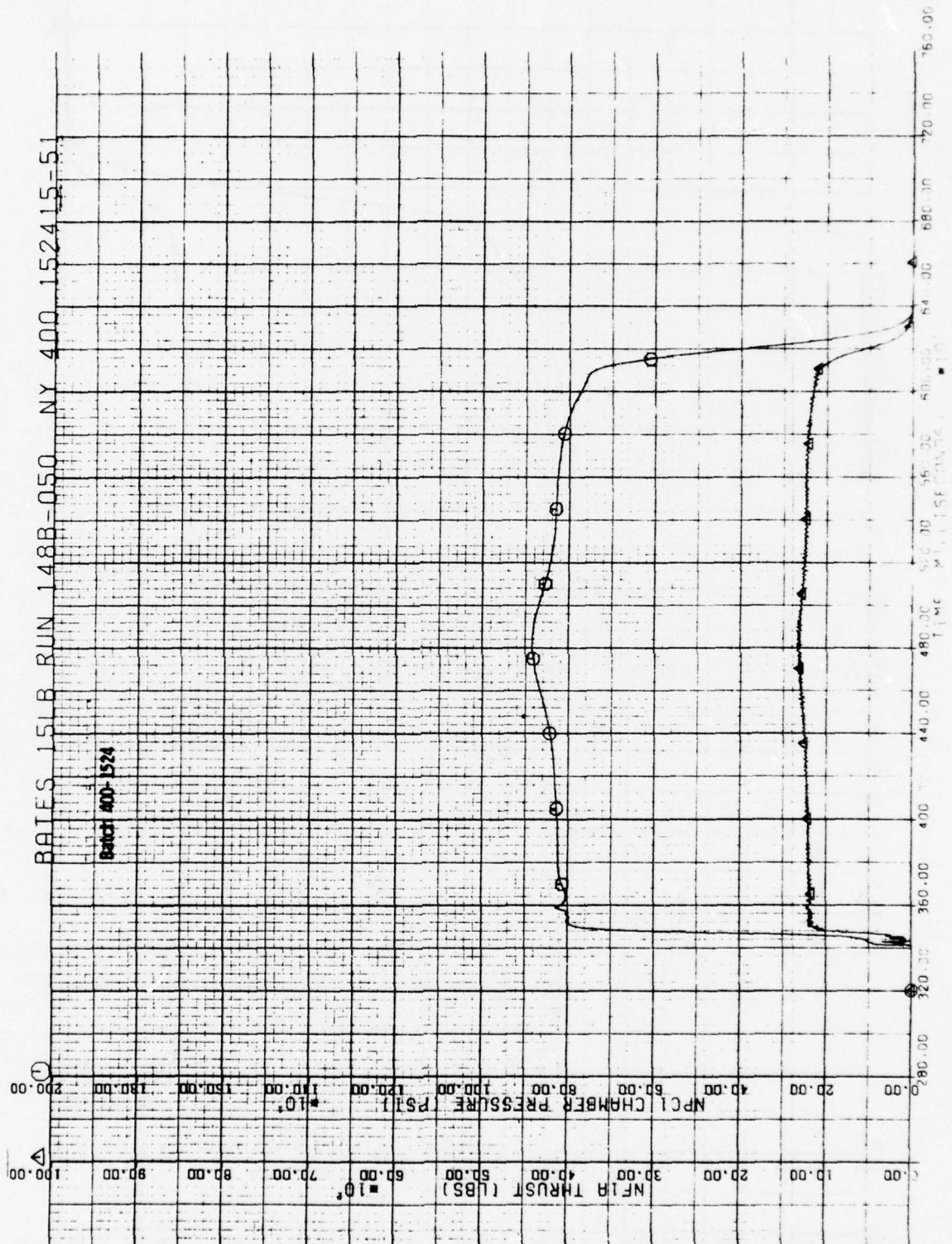
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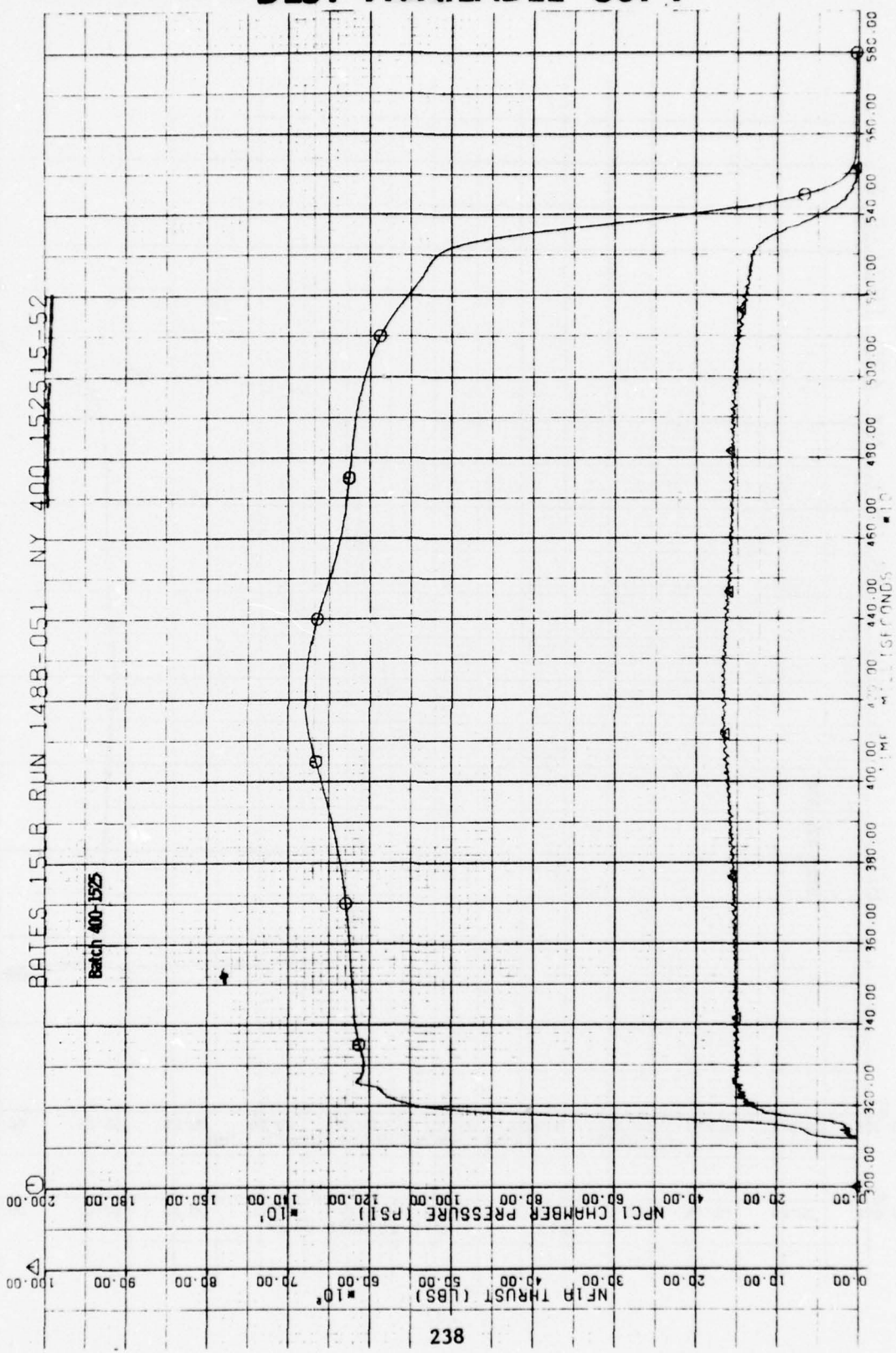
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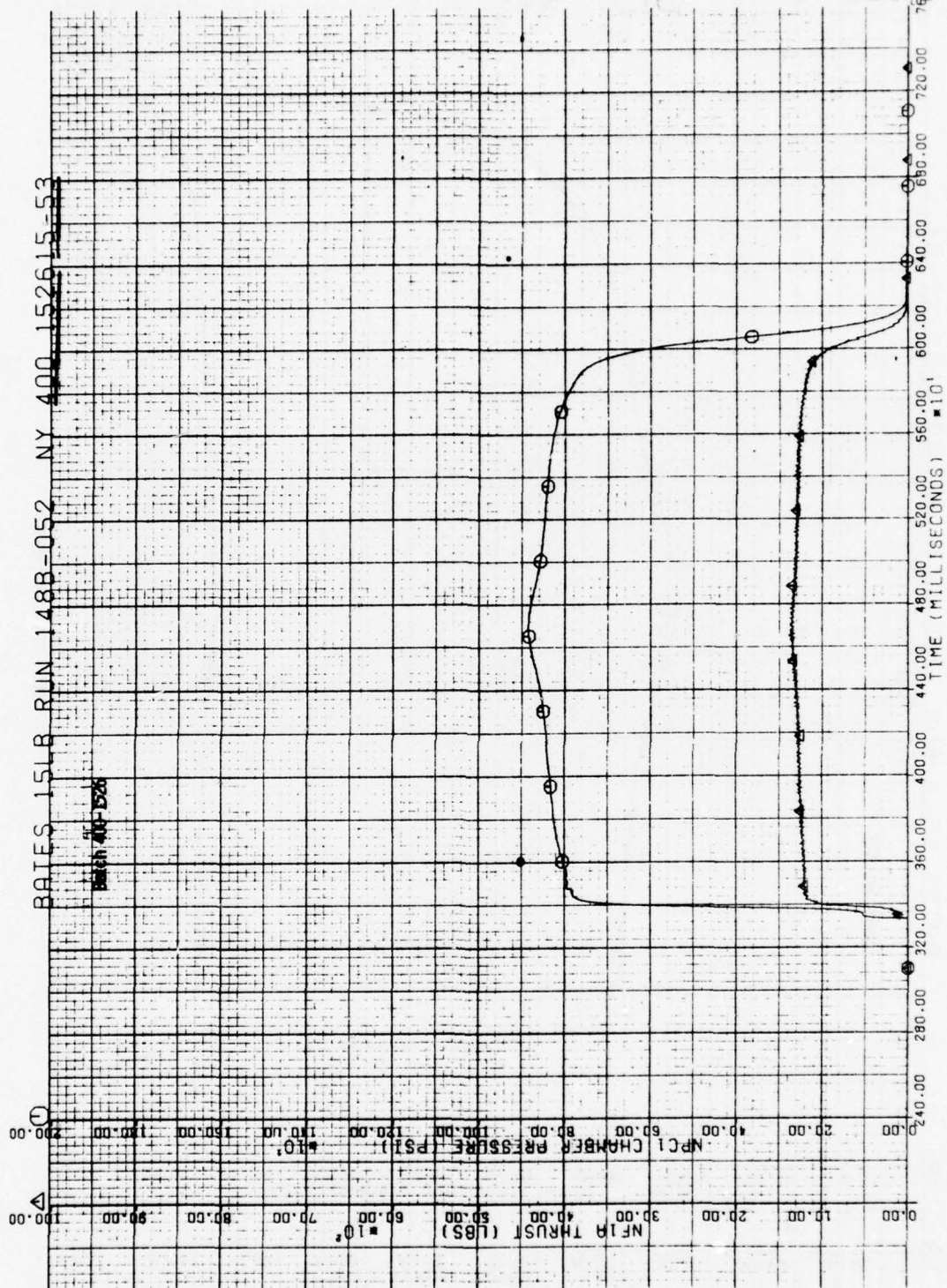
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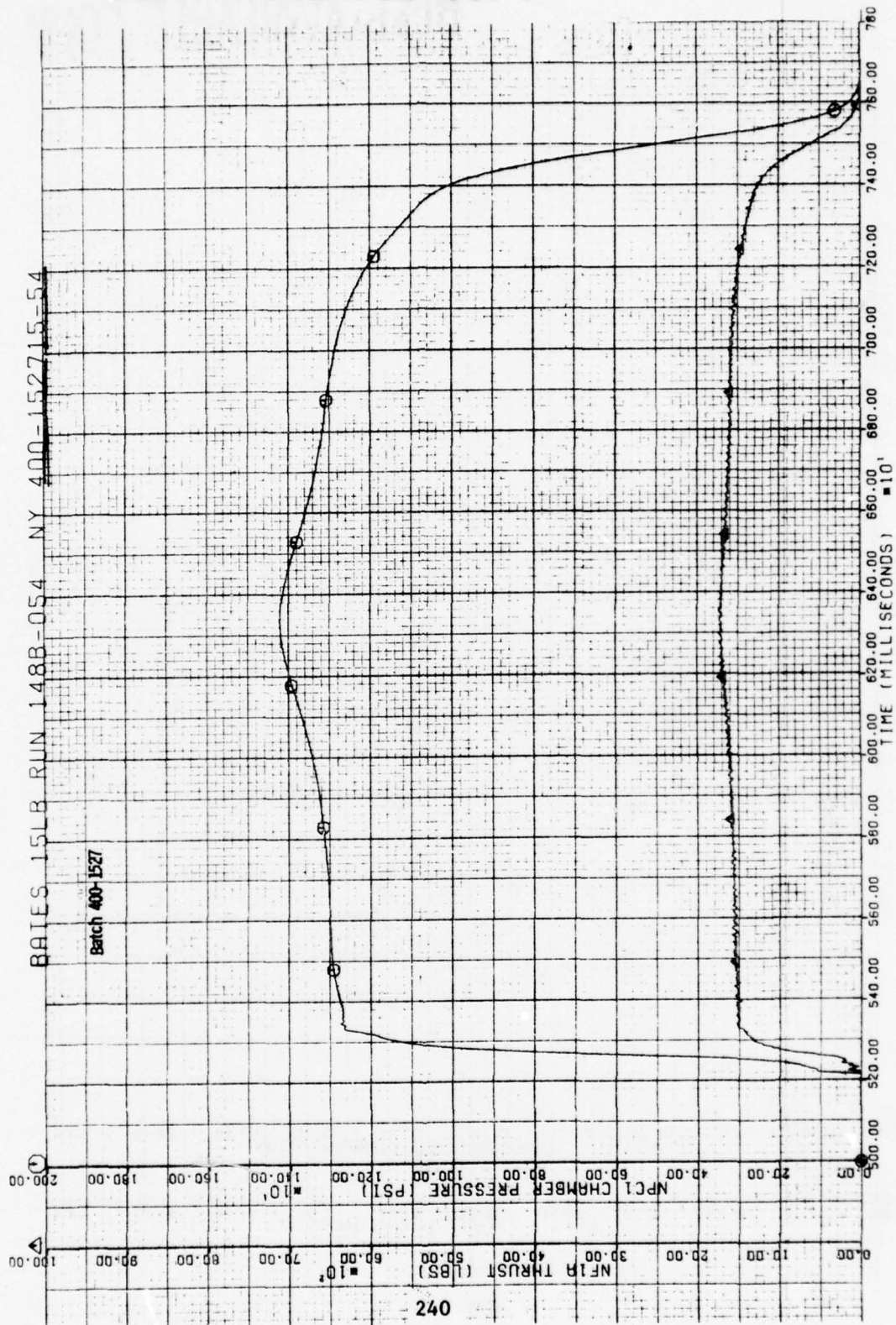
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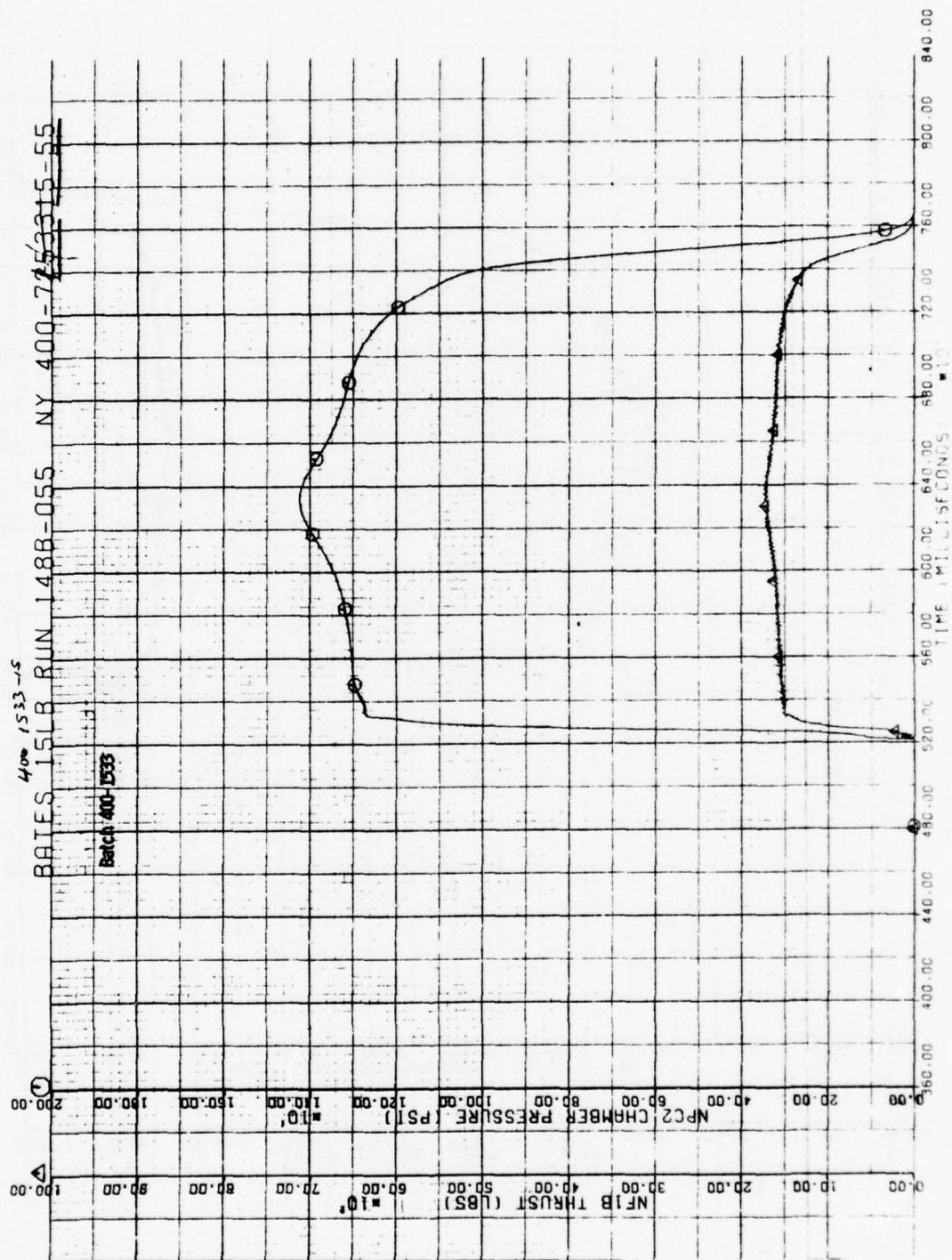
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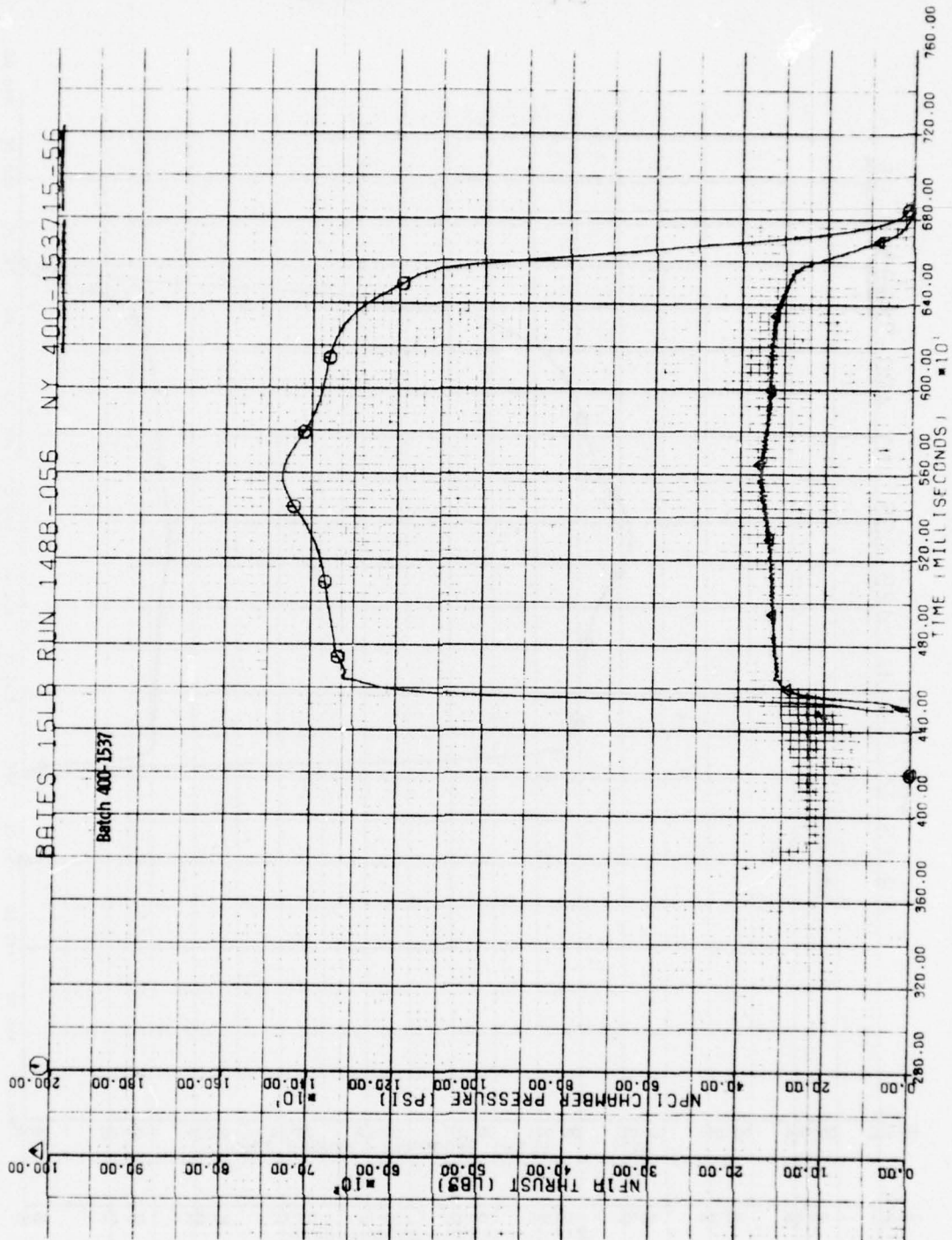
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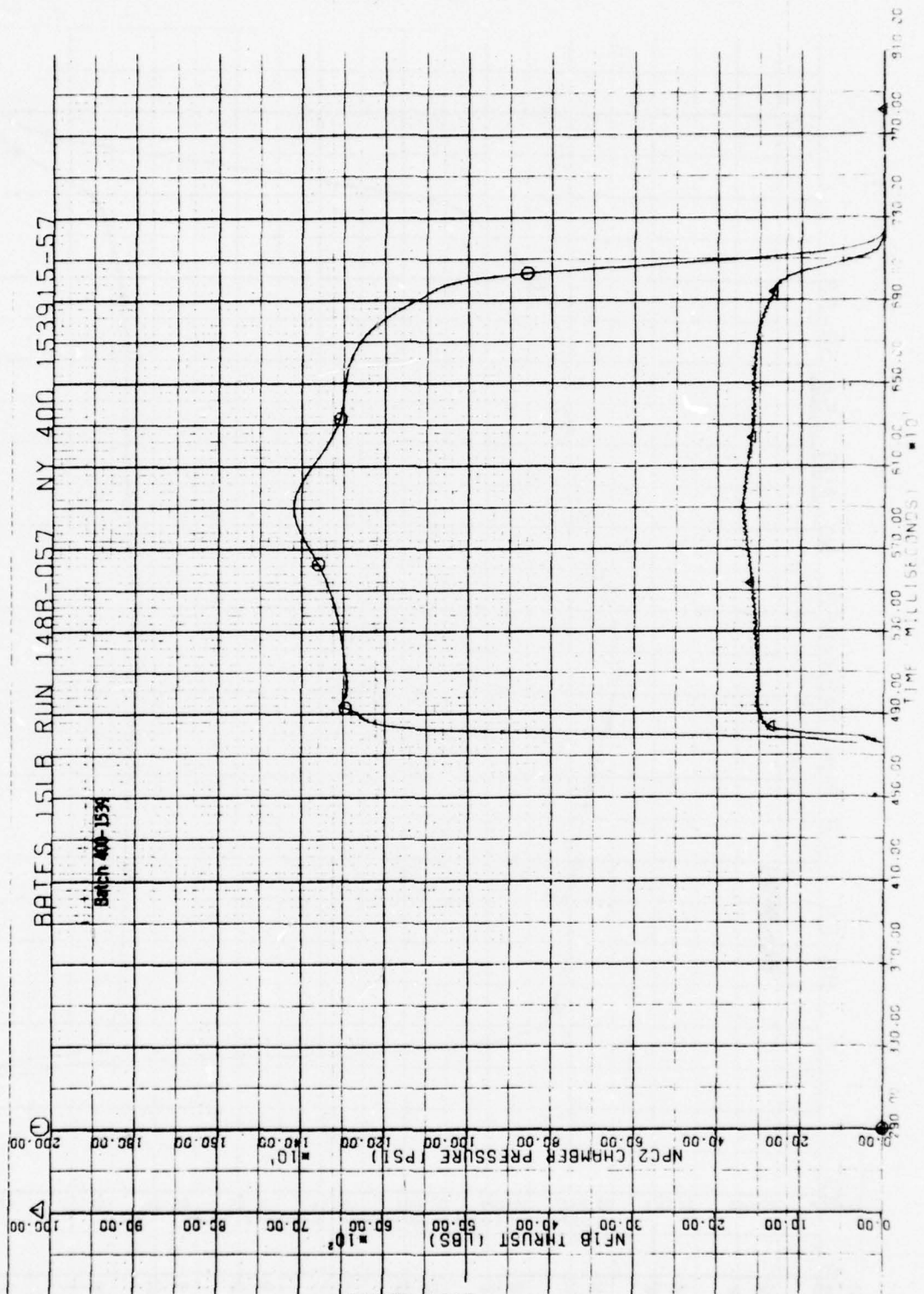
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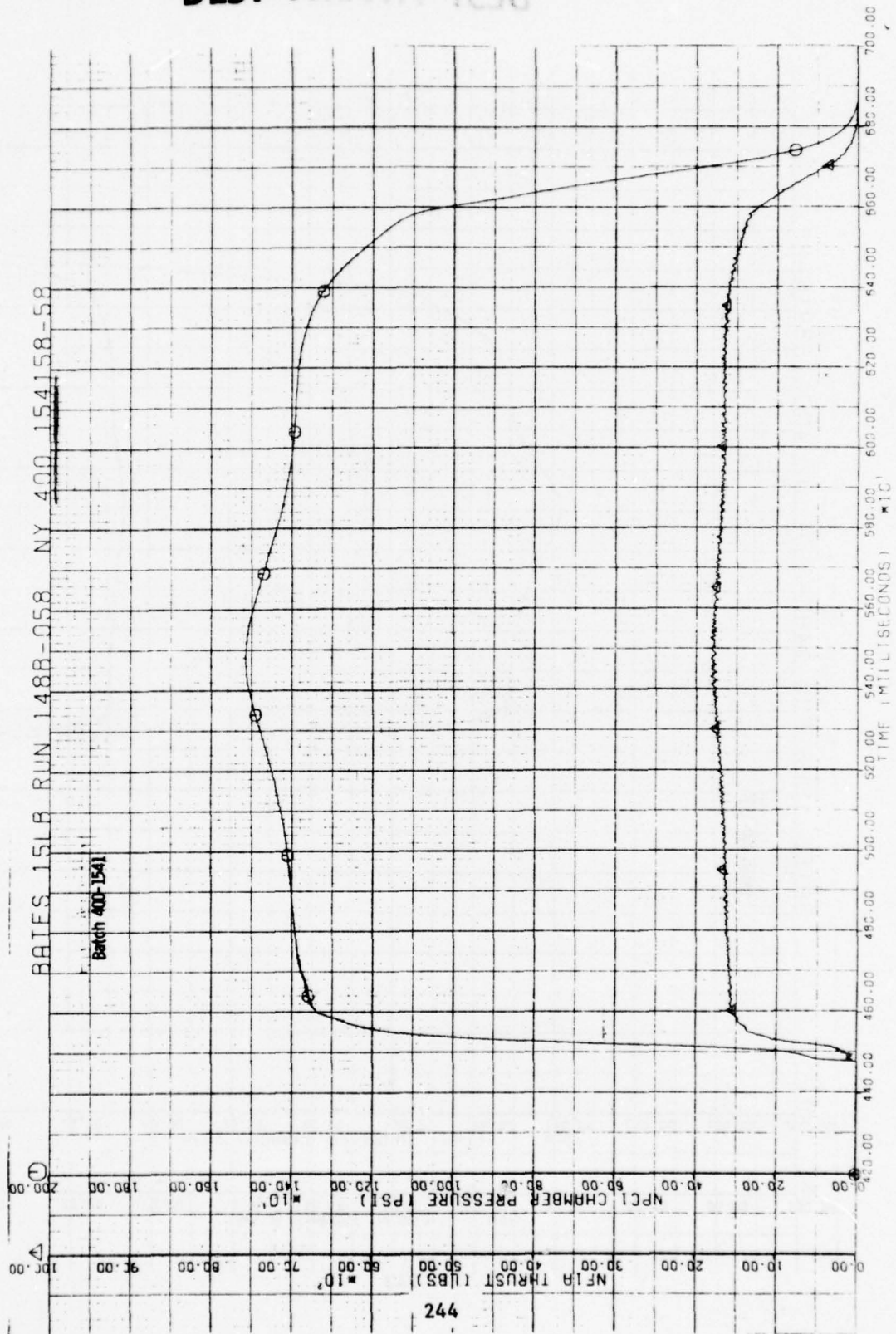
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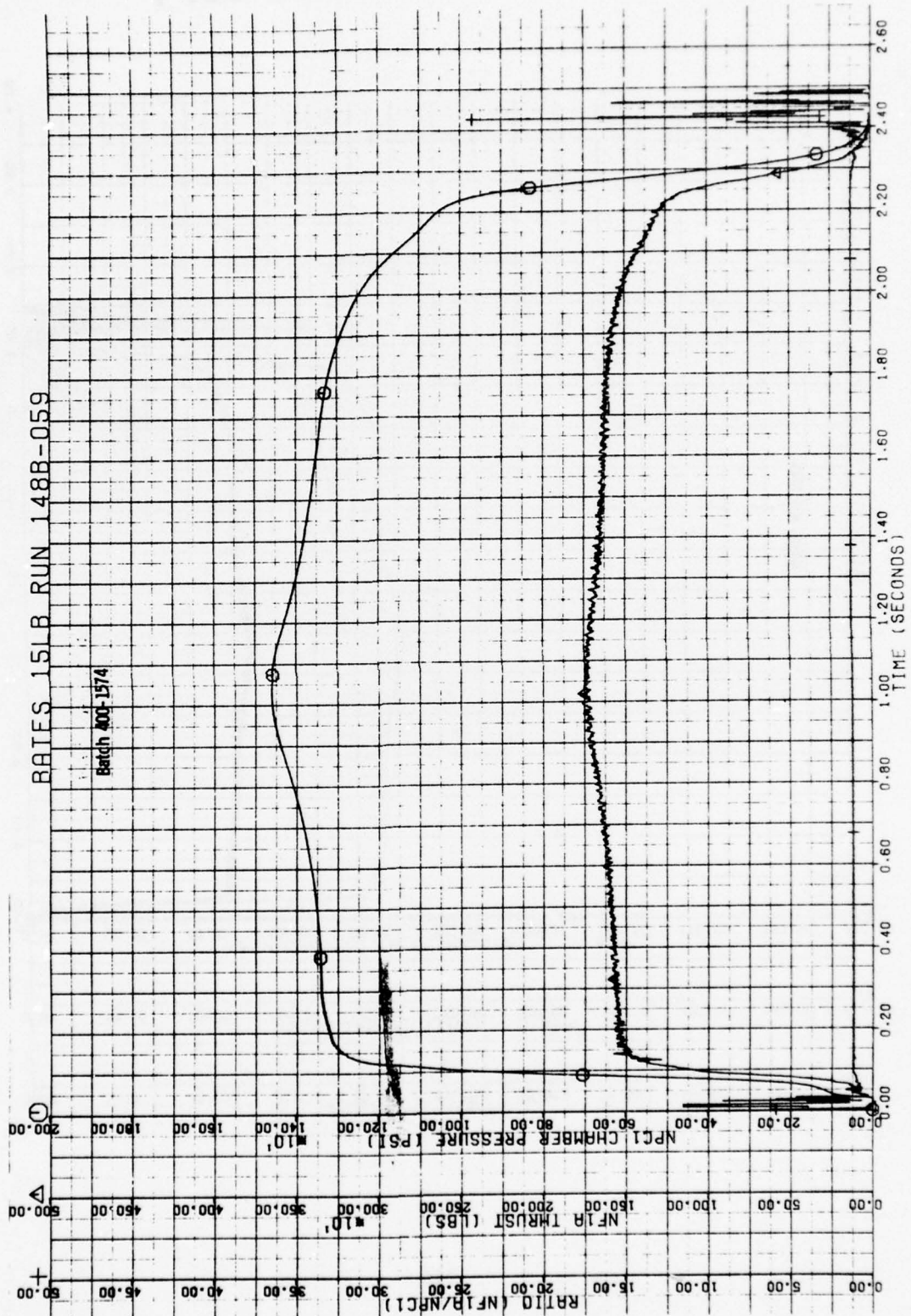
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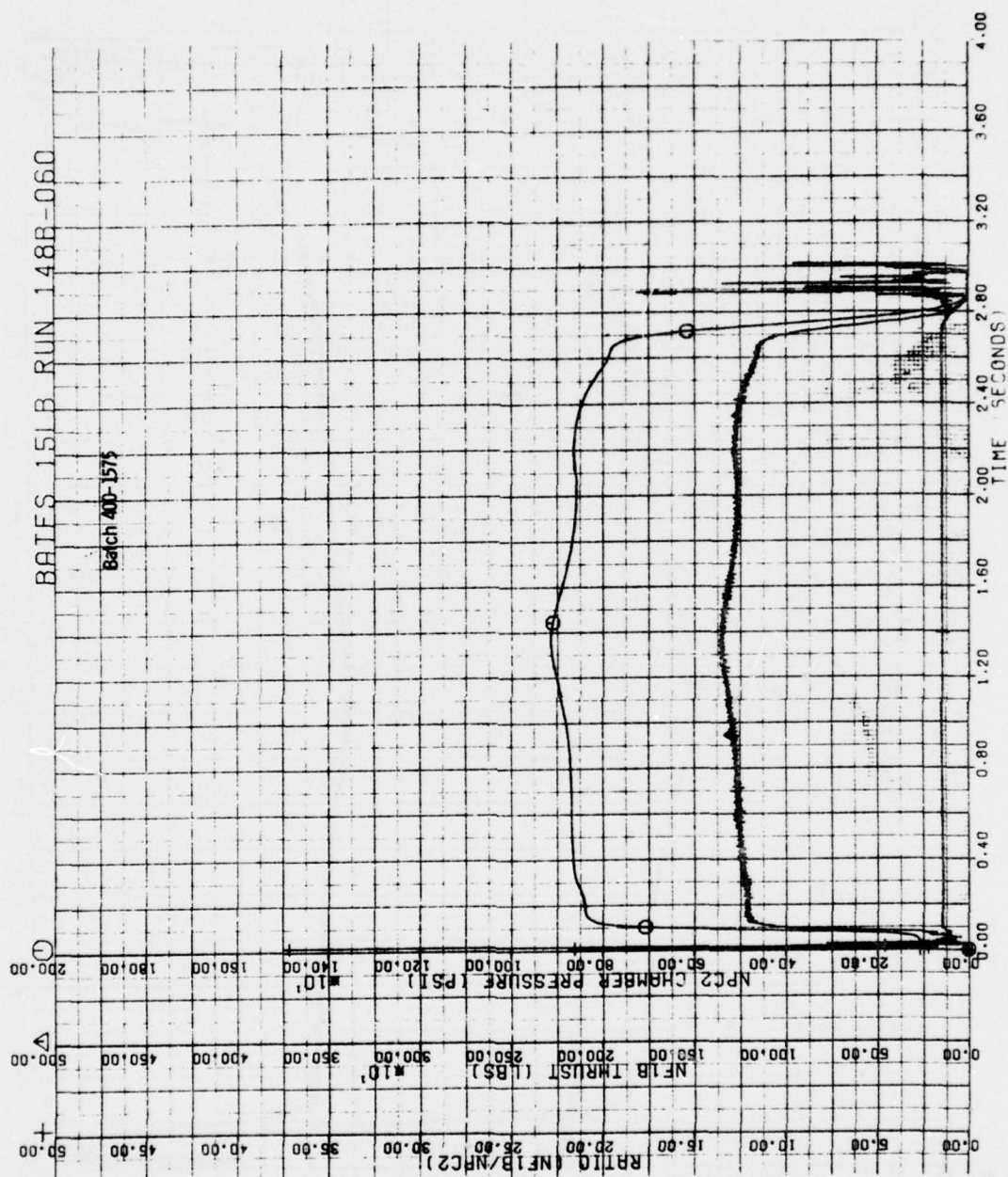
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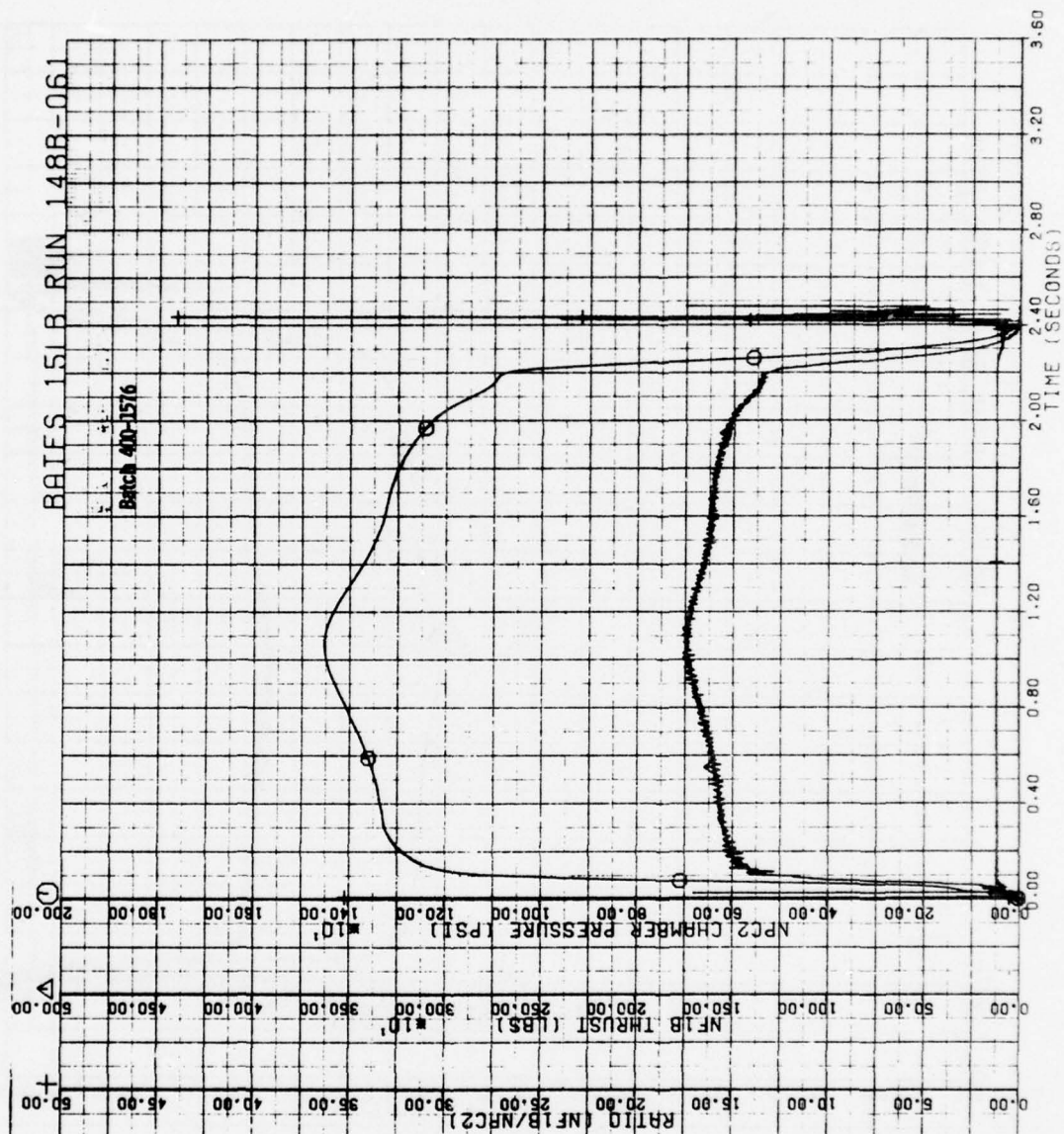
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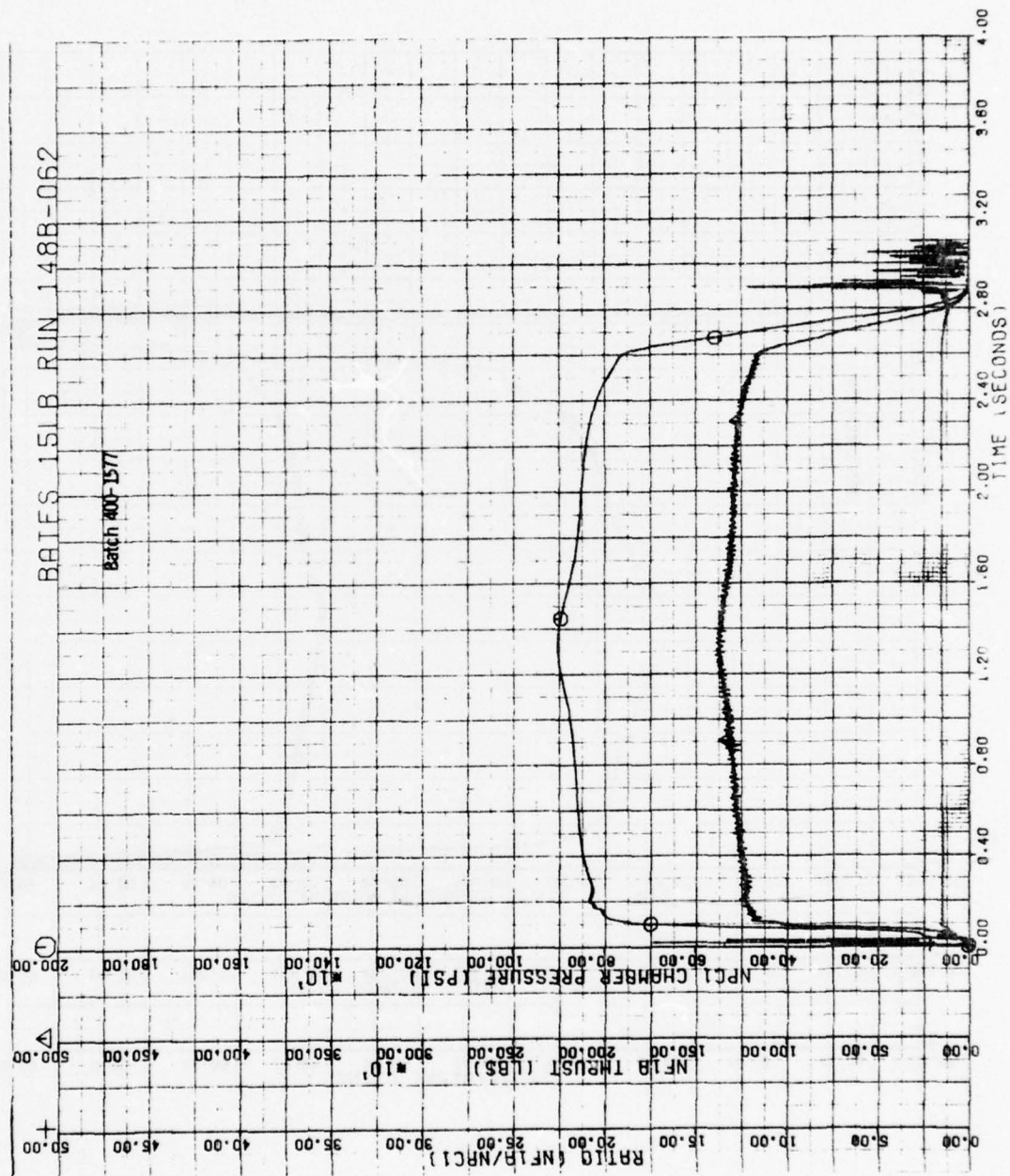
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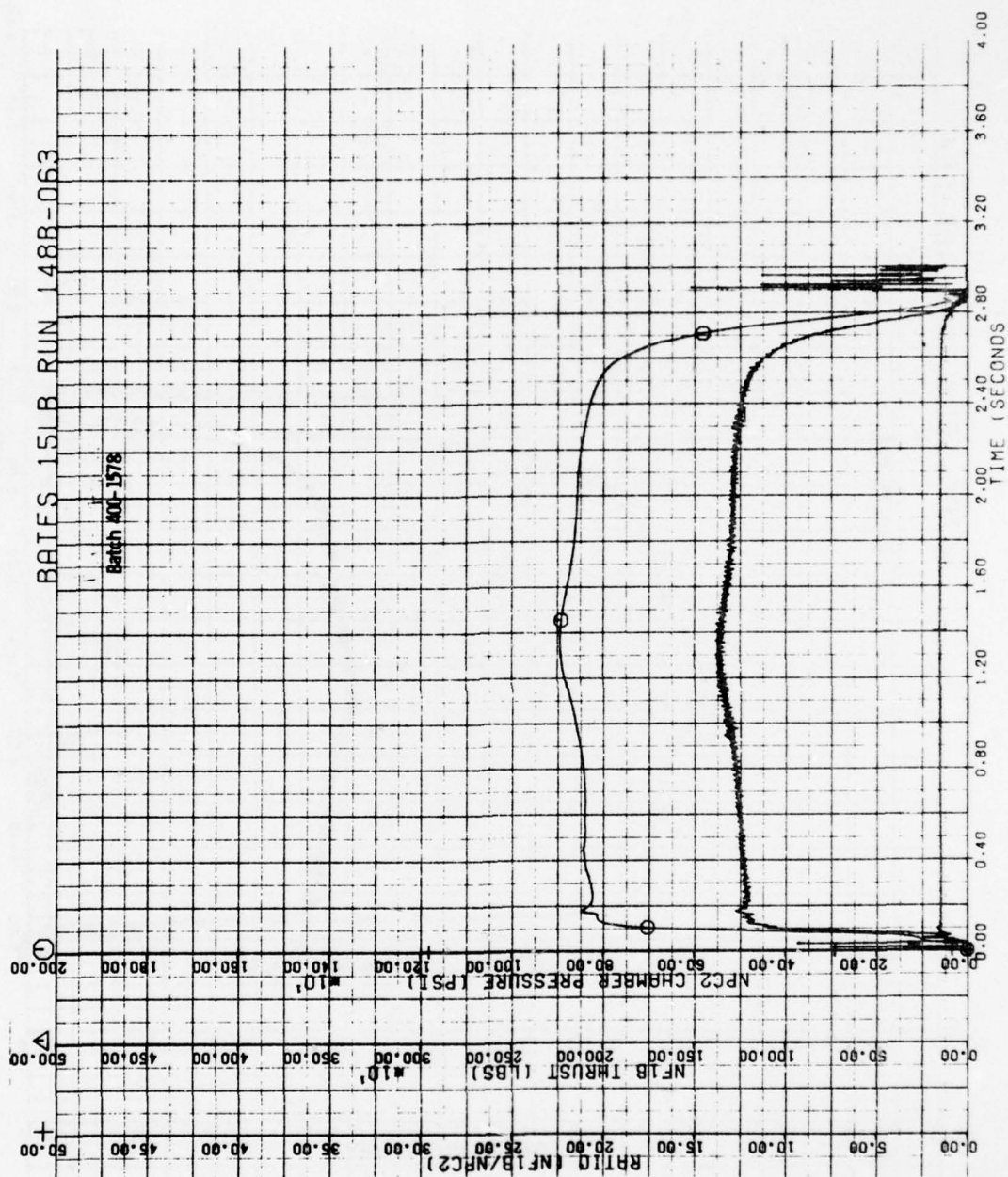
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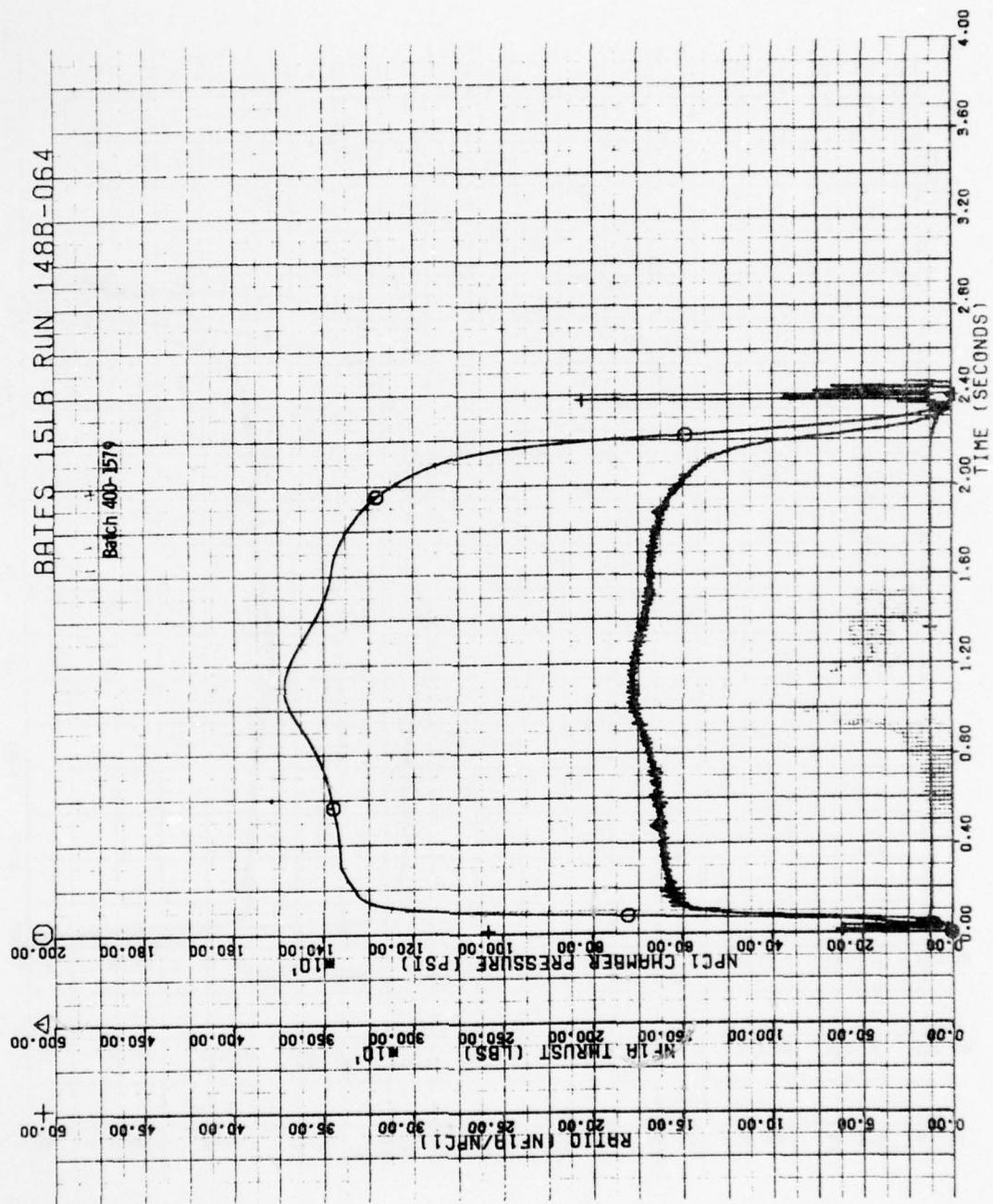
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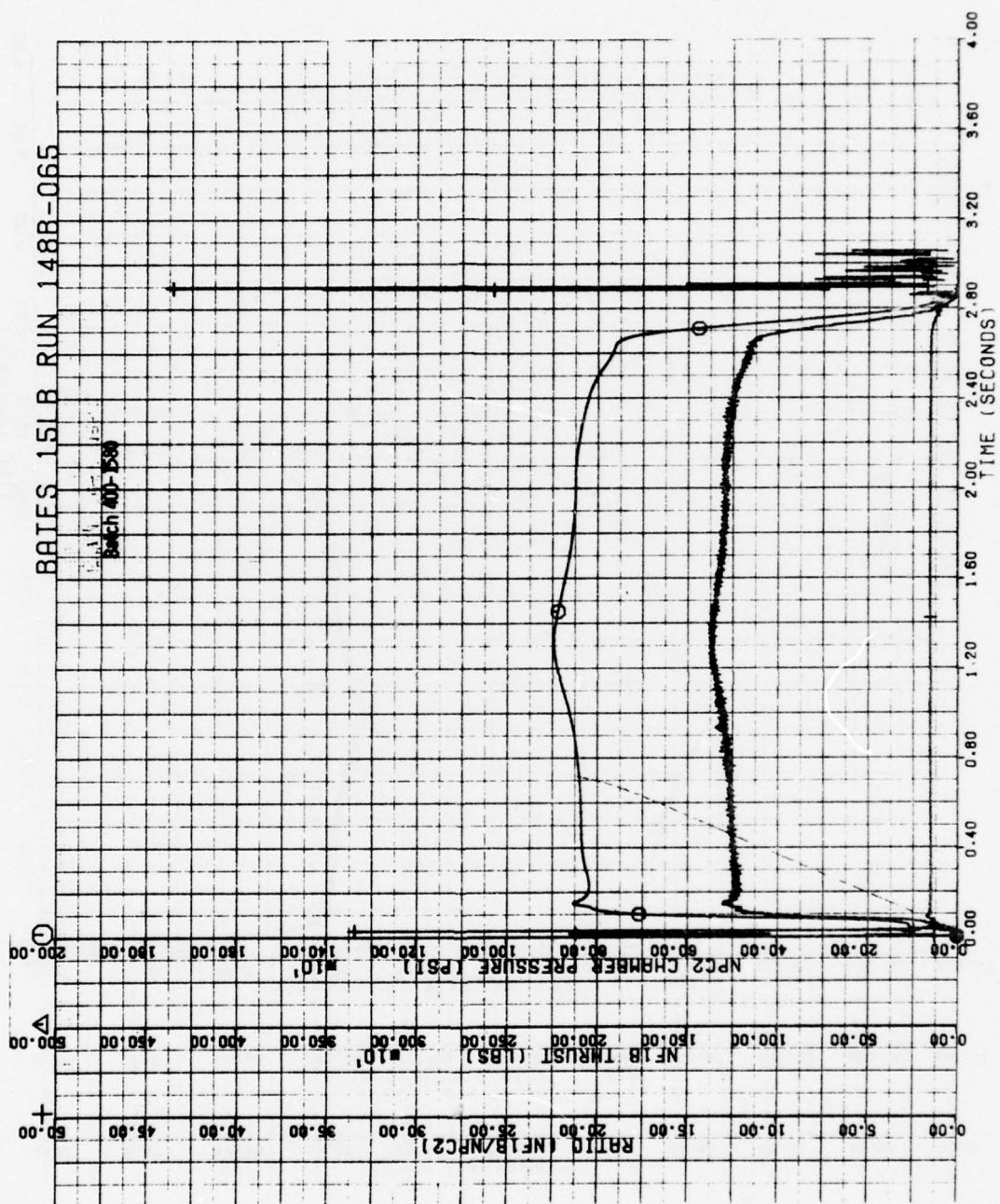
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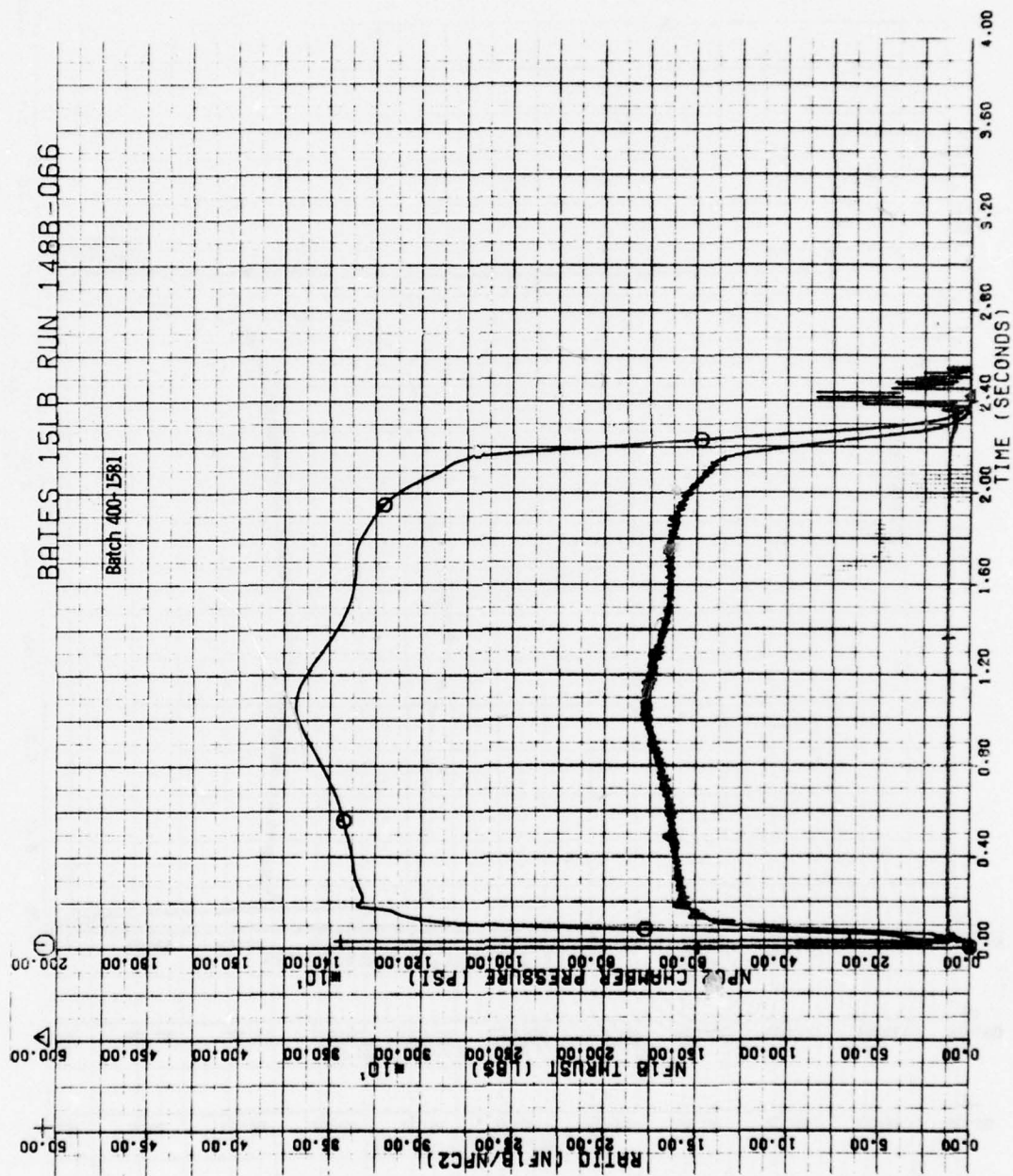
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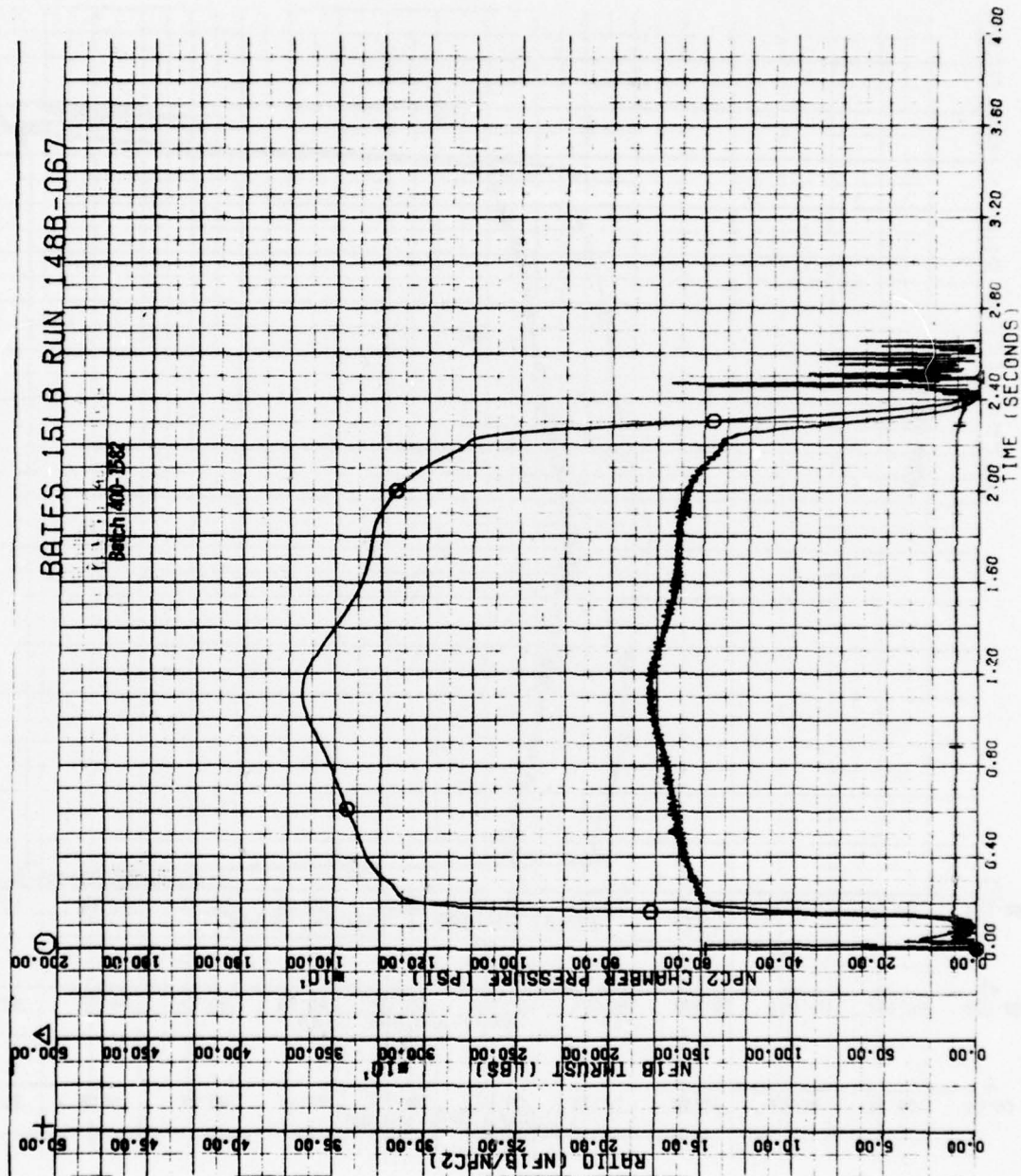
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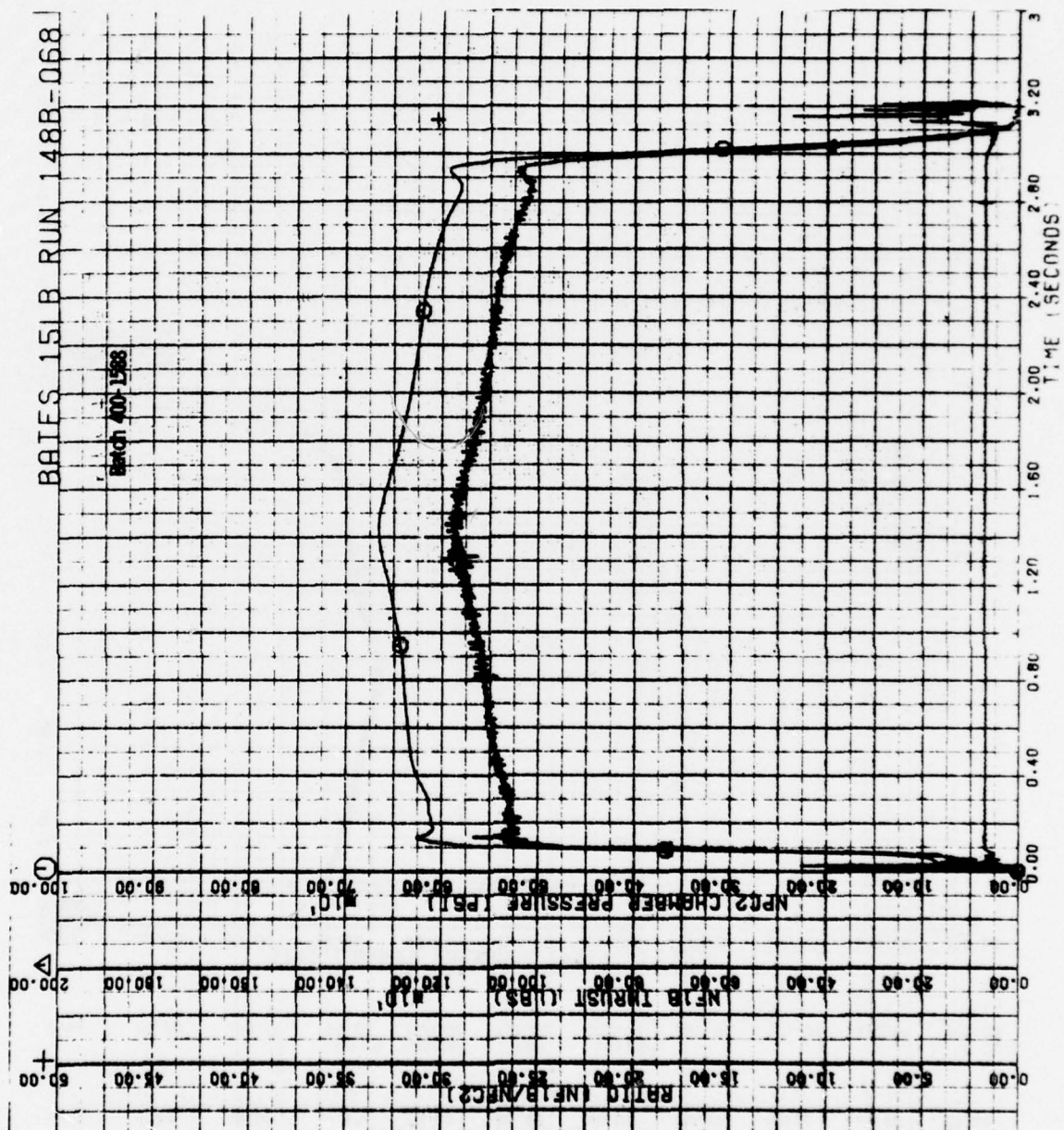
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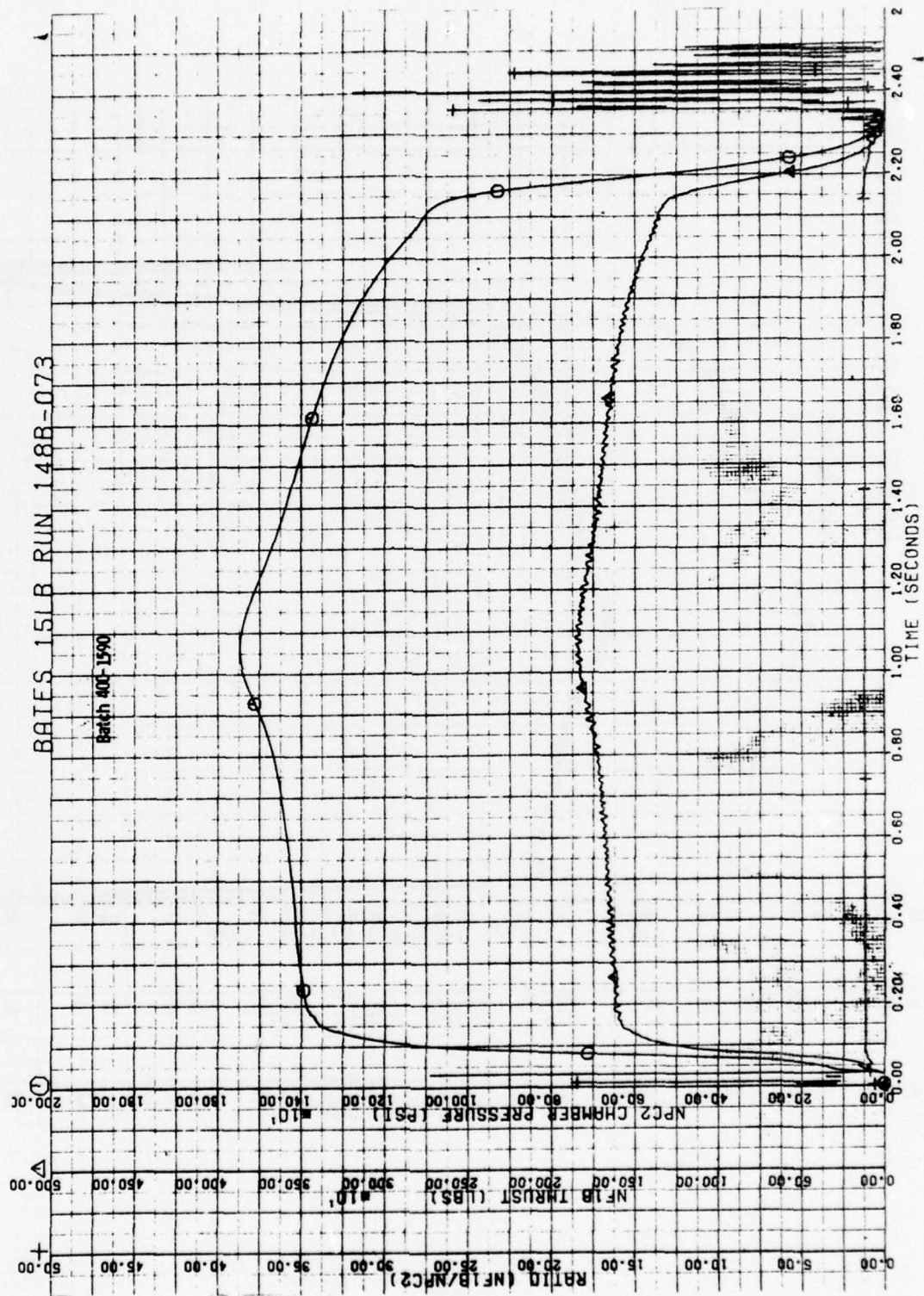
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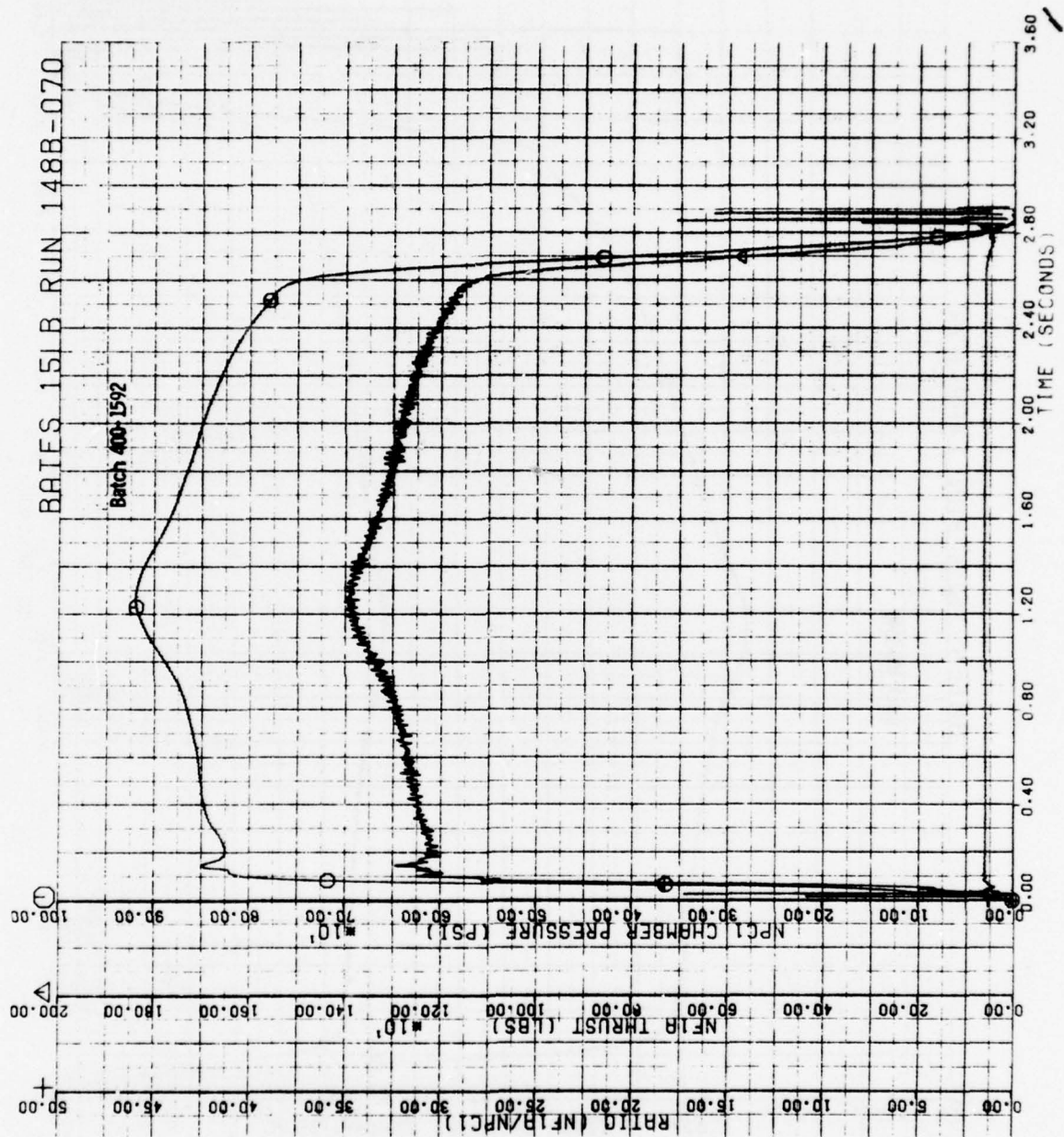
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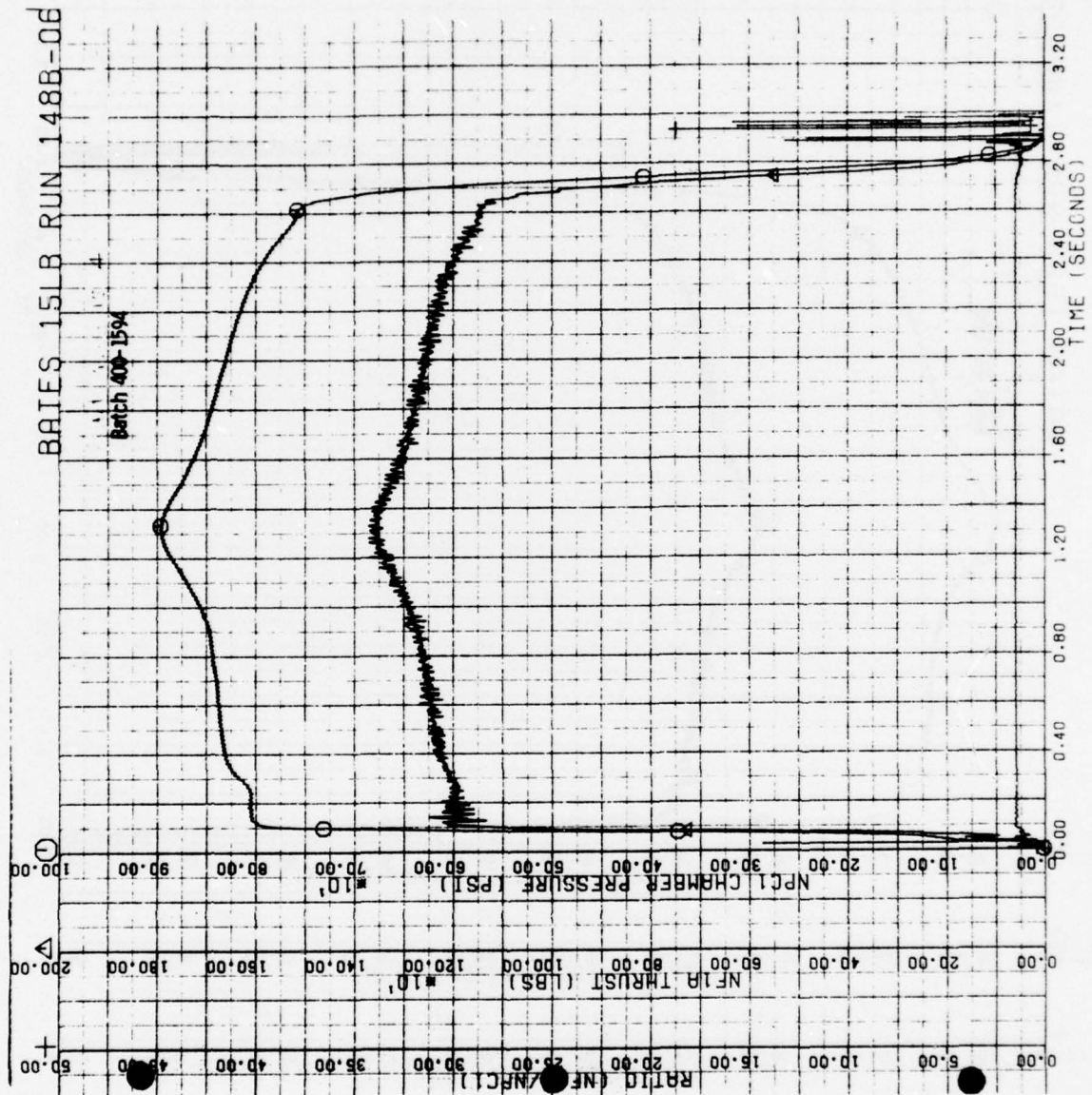
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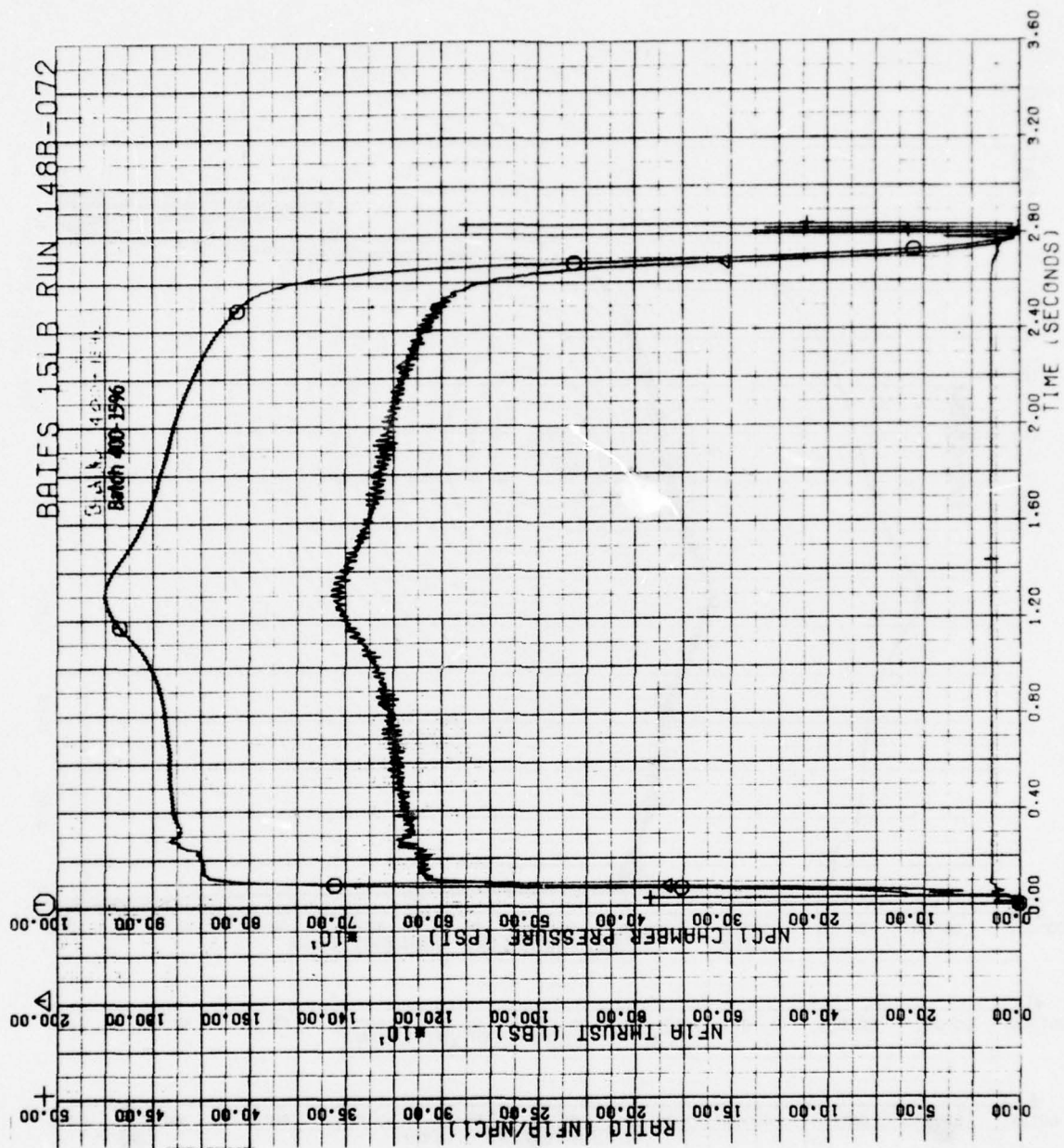
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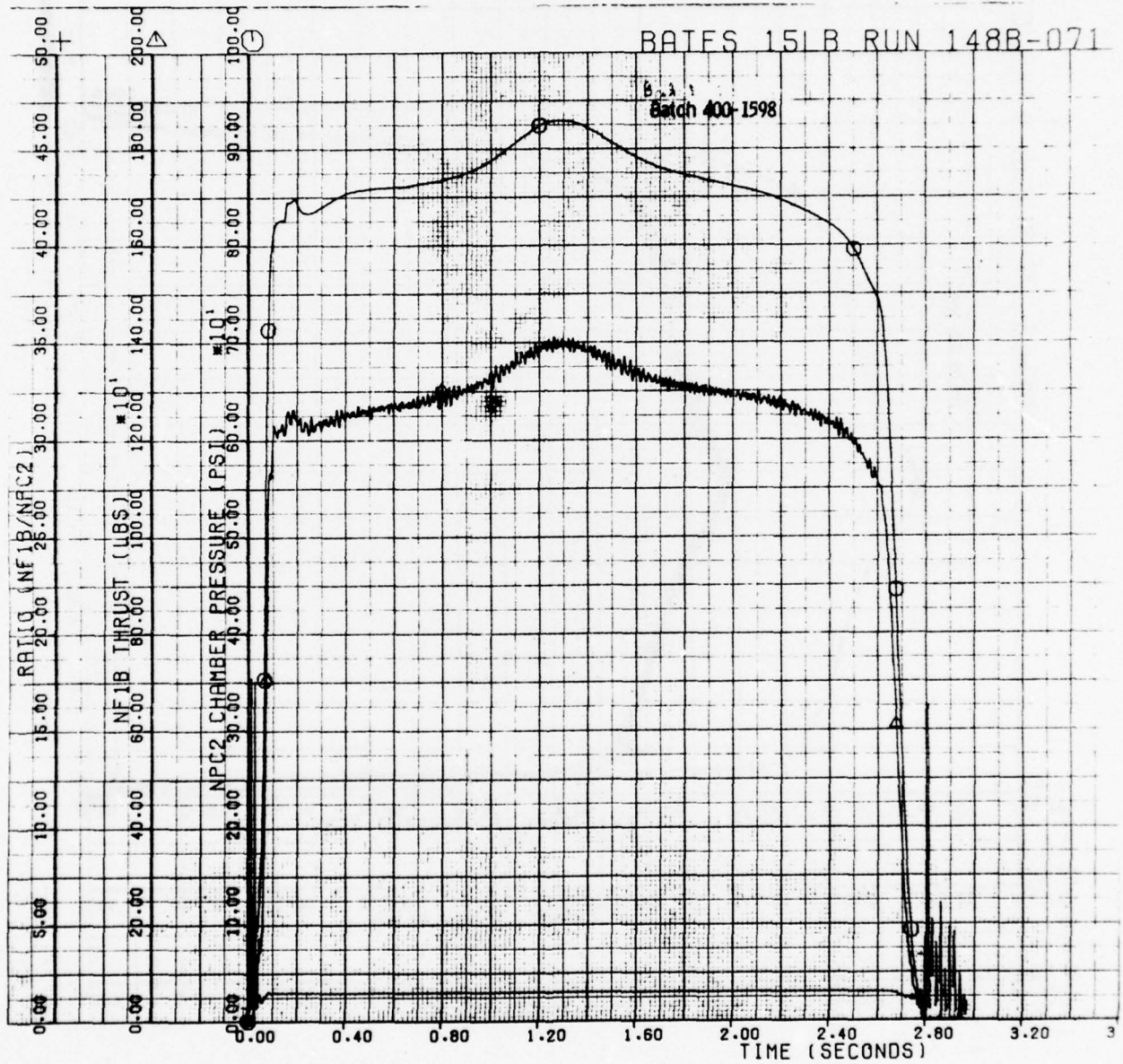
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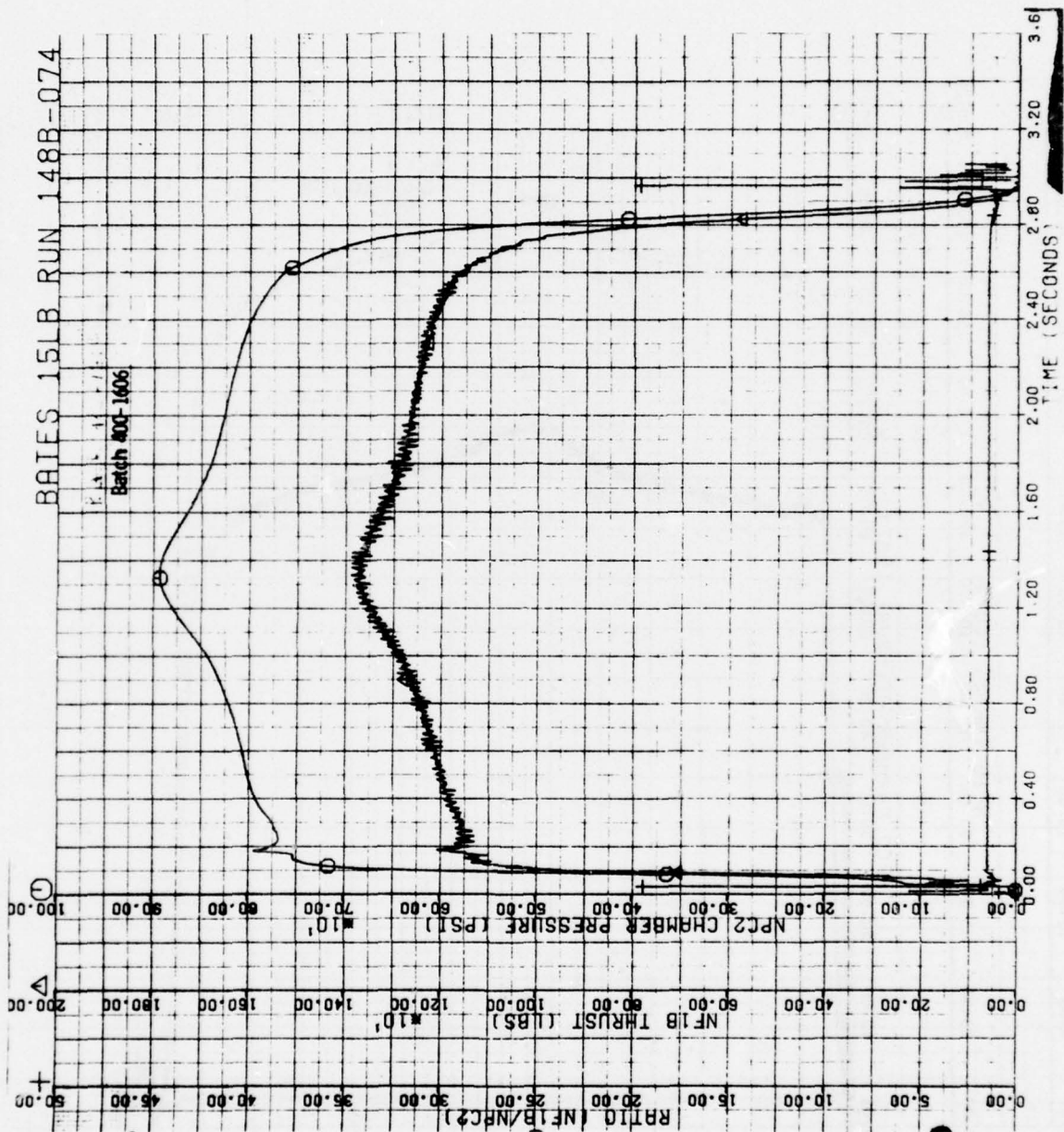
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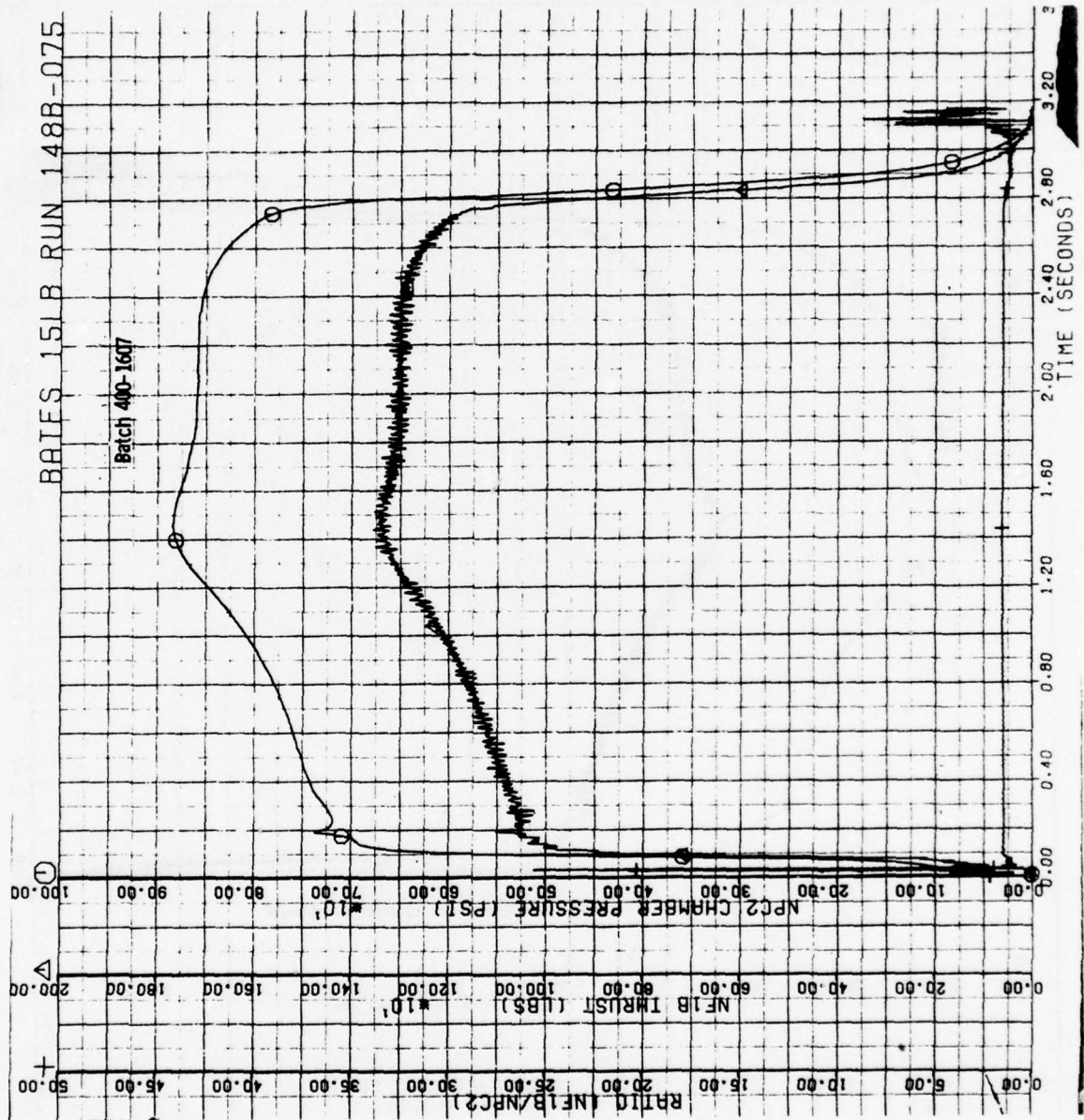
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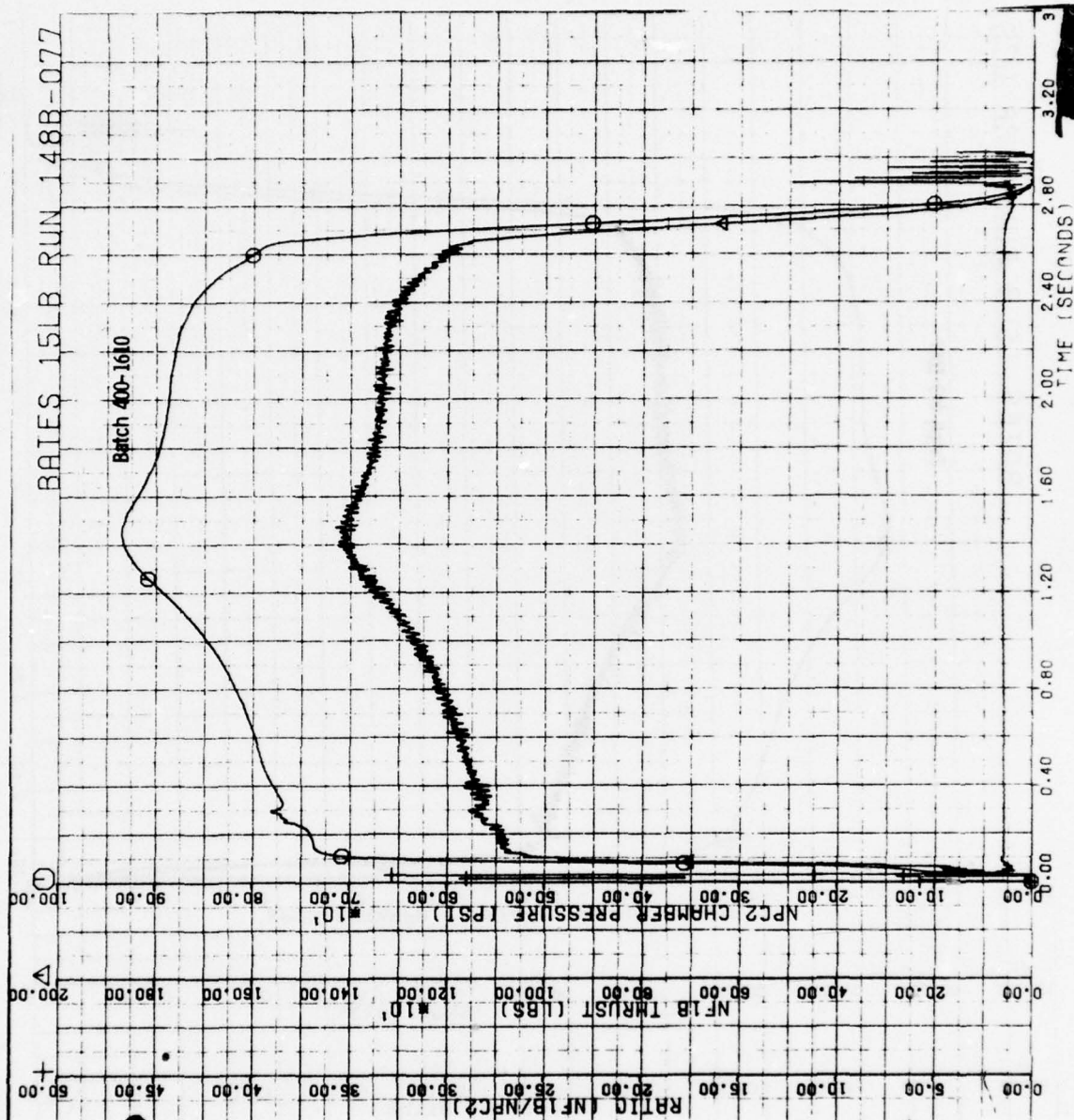
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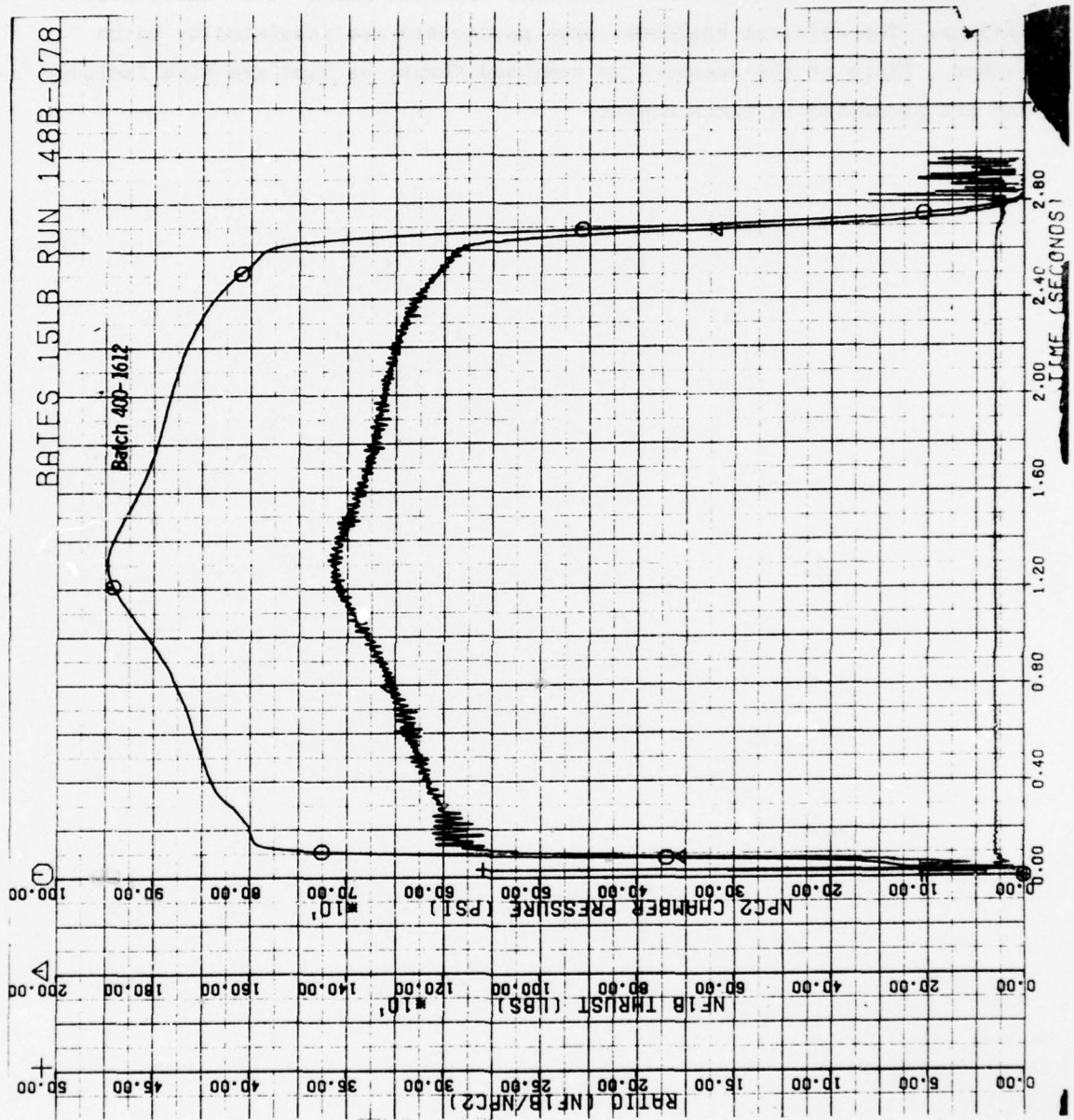
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5.0 SEVENTY-POUND BATES TEST DATA

This section presents the test data from the AFRPL 70-1b BATES test firings. The critical ballistic test parameters are tabulated by batch number. Plots of the pressure vs time and thrust vs time are also included and are presented by batch number.

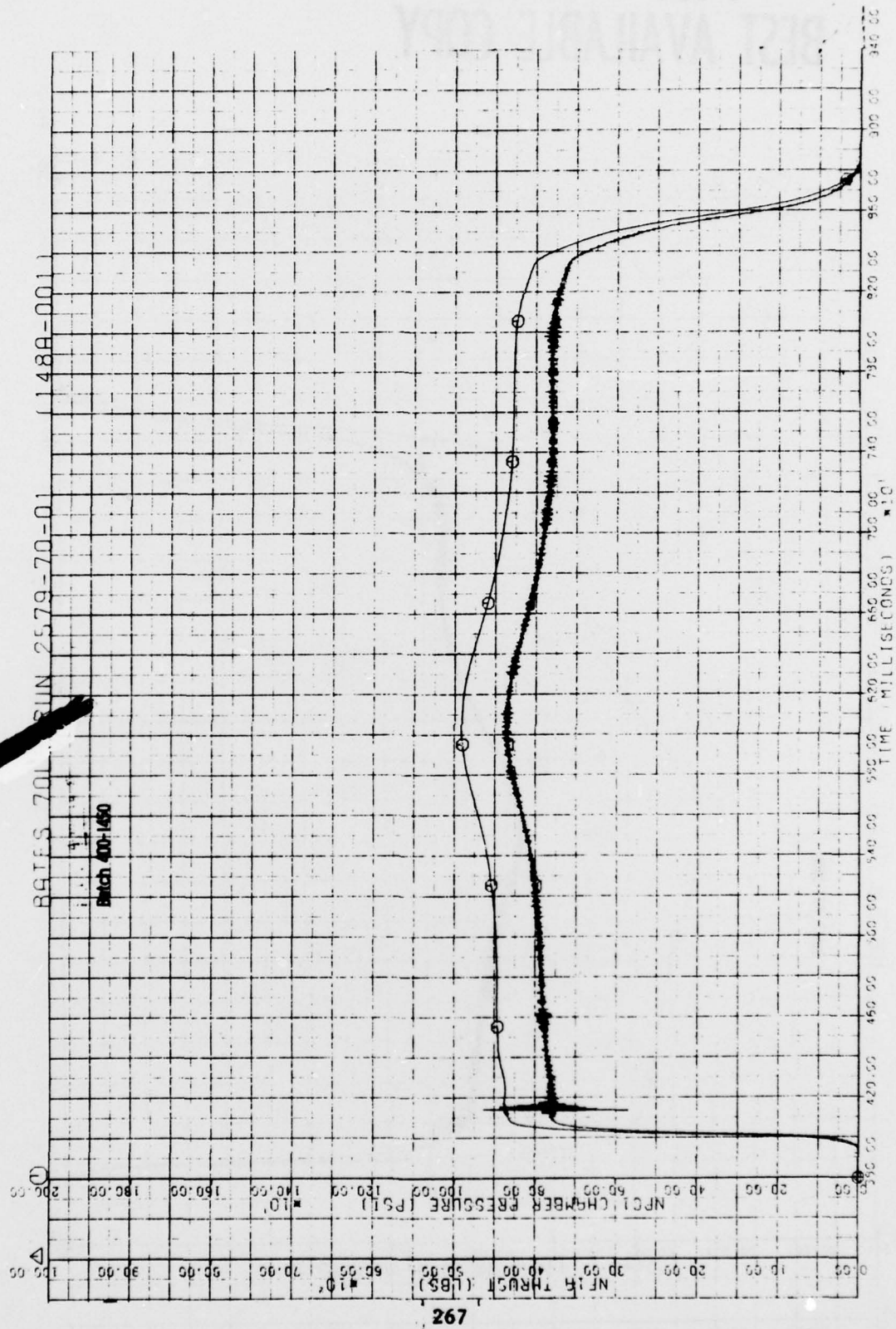
70-LB BATES DATA, 70°F

400-gal Batch No.	Propellant Cast in 34-in. Cartridge		Propellant Weight, lb	Initial Throat Diameter, in.	Throat Erosion Rate, mils/sec	Expansion Ratio	Action Time, sec	Action Time Average Chamber Pressure, psia	Burning Rate, in./sec	Measured c, ft/sec	Delivered Specific Impulse, sec	Isp, 15-deg RA MC, sec	Efficiency Isp, 15-deg RA MC, %
	P/N	S/N											
1450	N/A	N/A	74.19	1.87	3.6	9.443	4.665	881	0.393	5.016	242.2	243.2	0.921
1450	N/A	N/A	73.97	1.653	10	9.385	3.76	1,376	0.490	5.092	249.7	242.7	0.918
1450	N/A	N/A	75.7	1.65	10	9.436	3.915	1,357	0.482	5.093	250.0	243.1	0.920
1455	CI1479-02-01	2579-02	75.46	1.65	8.7	9.461	4.335	1,232	0.435	5.124	248.1	242.6	0.9182
1457	CI1479-02-01	2579-02	73.0	1.65	9.9	9.466	3.954	1,213	0.471	5.150	248.8	242.4	0.9174
1459	CI1479-01-01	2579-01	73.24	1.65	8.8	9.487	3.810	1,371	0.477	5.144	250.7	243.6	0.9217
1496	CI1479-01-01	2579-07	73.83	1.65	11.3	9.442	3.570	1,434	0.505	5.199	251.4	243.7	0.9225
1498	CI1479-01-01	2579-07	73.73	1.655	11.2	9.381	3.616	1,444	0.496	5.144	252.3	244.5	0.9257
1500	CI1479-03-01	2579-08	75.27	1.651	11.4	9.423	3.55	1,501	0.523	5.148	252.4	244.0	0.9238
1506	CI1479-01-01	2579-09	75.9	1.663	11.9	9.226	3.784	1,388	0.498	5.020	250.3	243.3	0.921
1508	CI1479-01-01	2579-09	75.76	1.65	12.7	9.372	3.577	1,464	0.508	5.106	251.5	243.5	0.922
1540	CI2185-02-01	2579-12	73.94	1.654	14.4	11.65	3.933	1,296	0.459	5.125	*	*	*
1542	CI2185-01-01	2579-10	74.22	1.653	12.76	11.726	3.880	1,328	0.461	5.109	250.8	242.5	0.9189

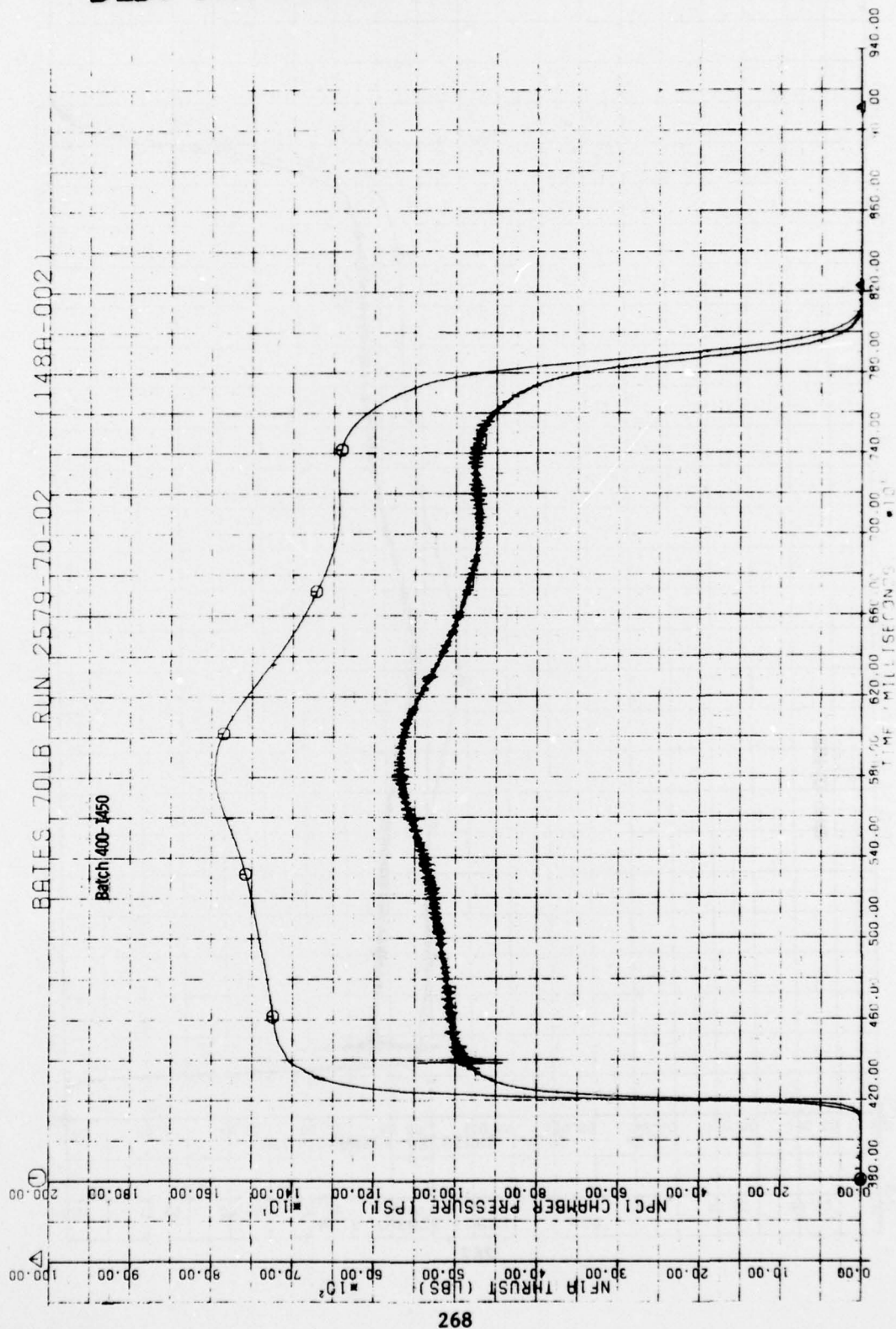
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* Thrust not reported due to 2% difference between channels.

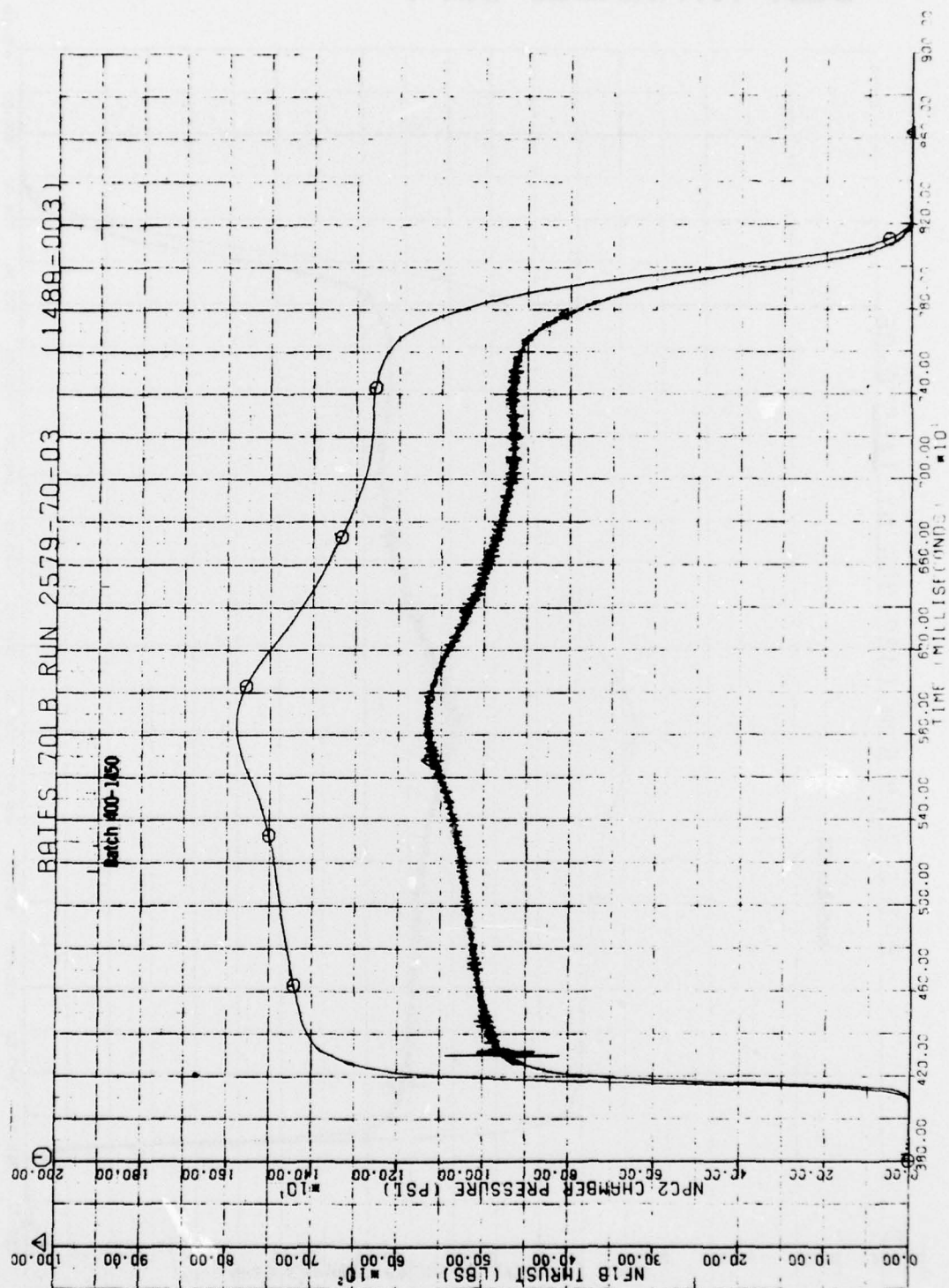
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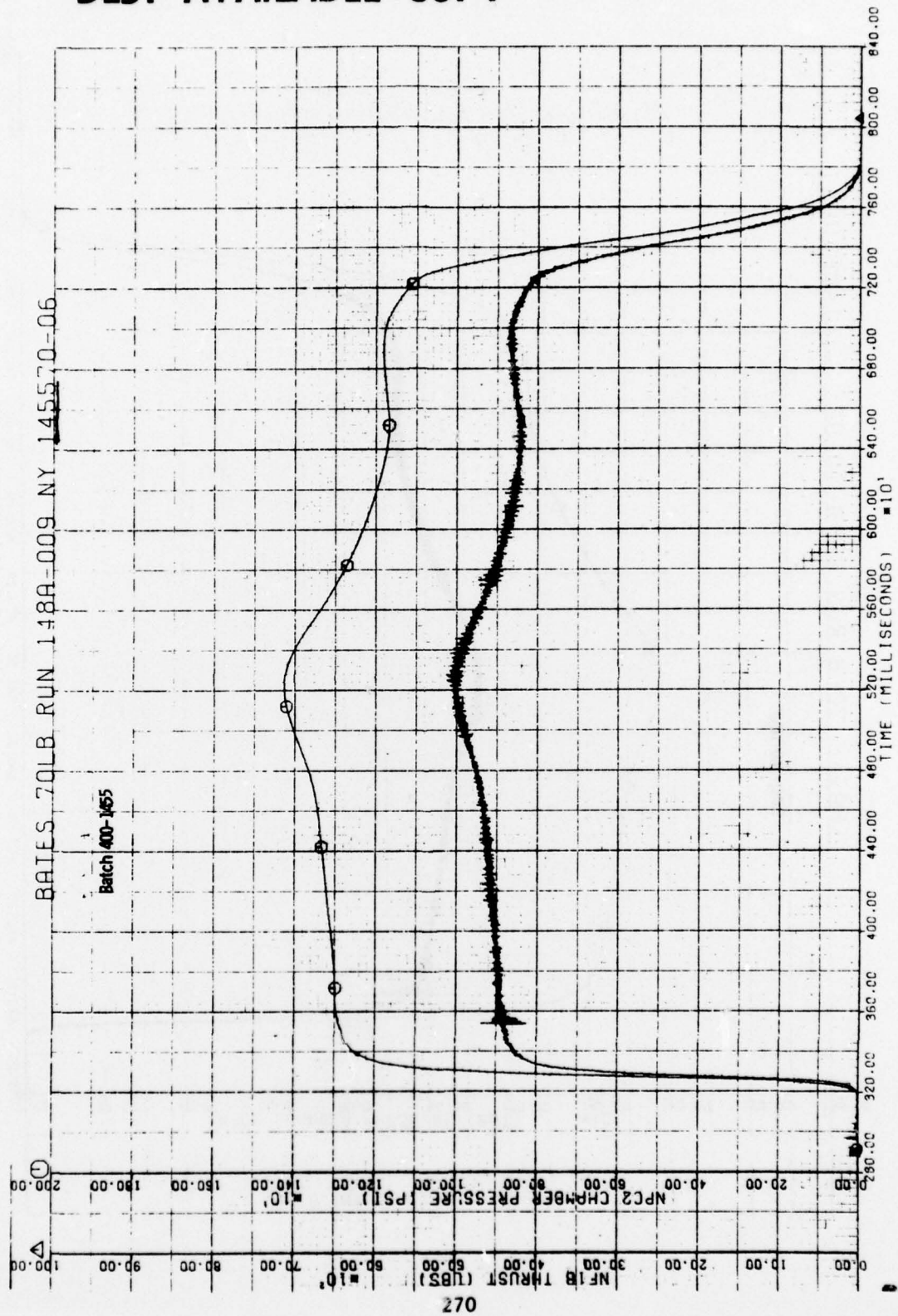
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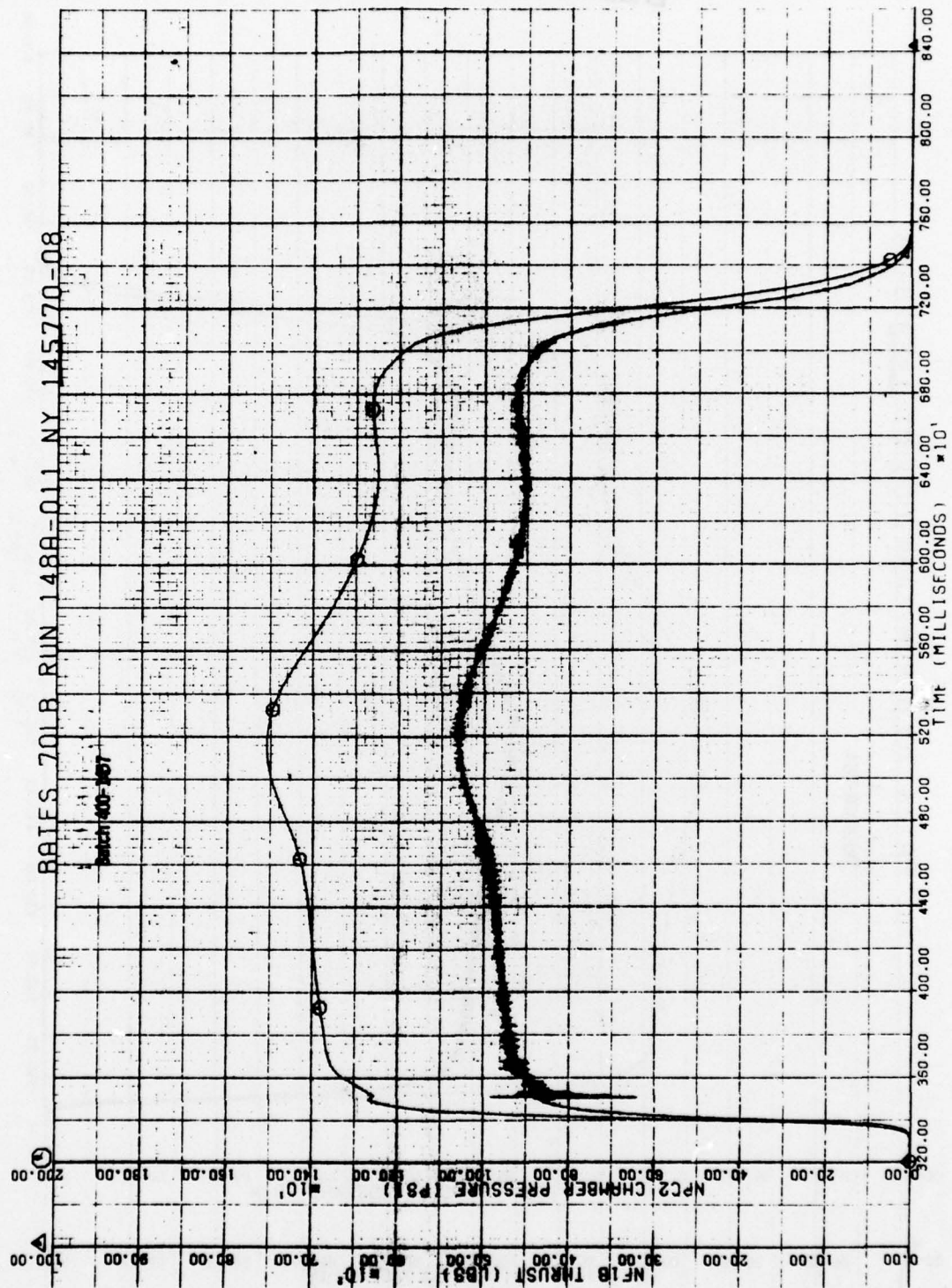
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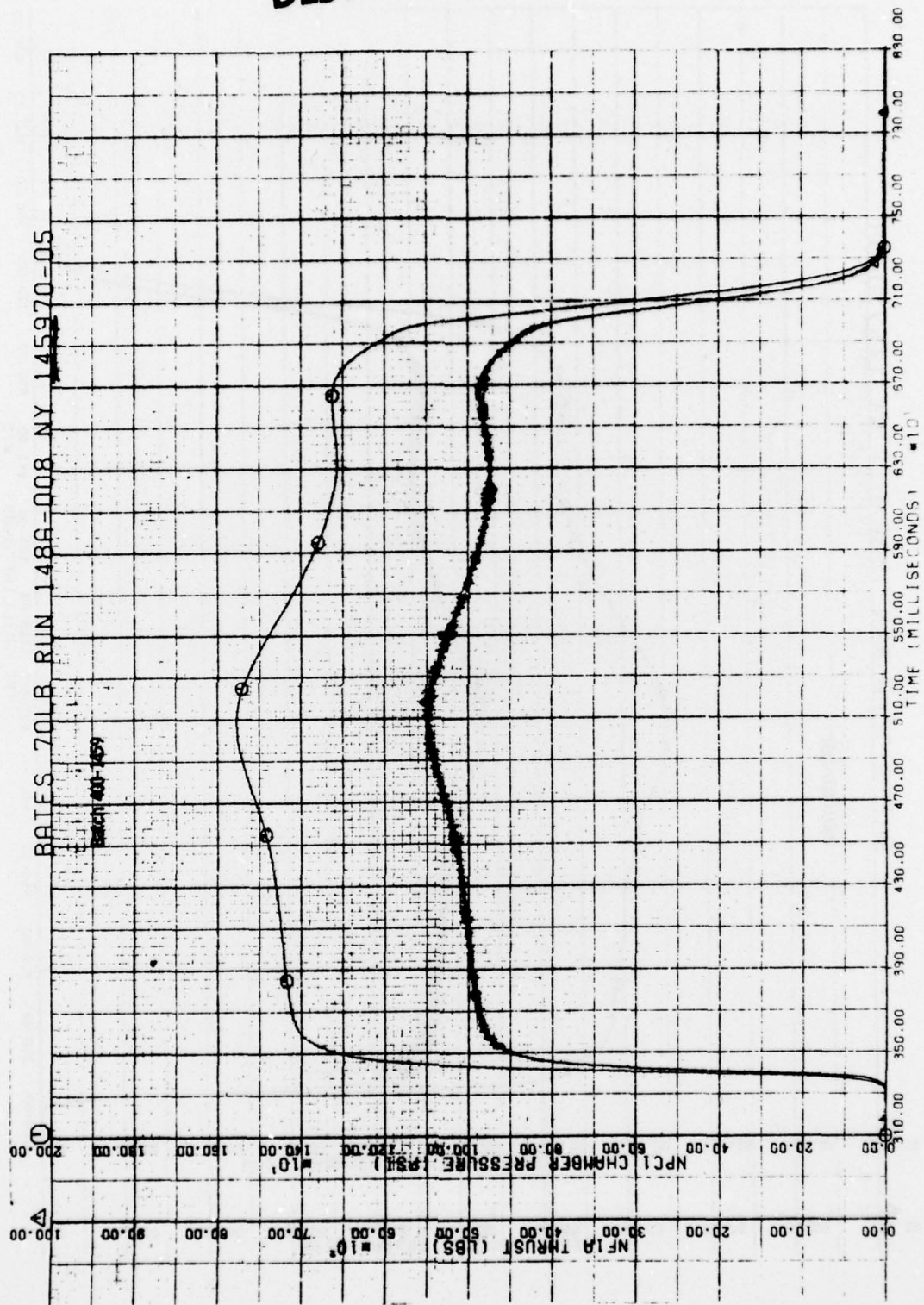
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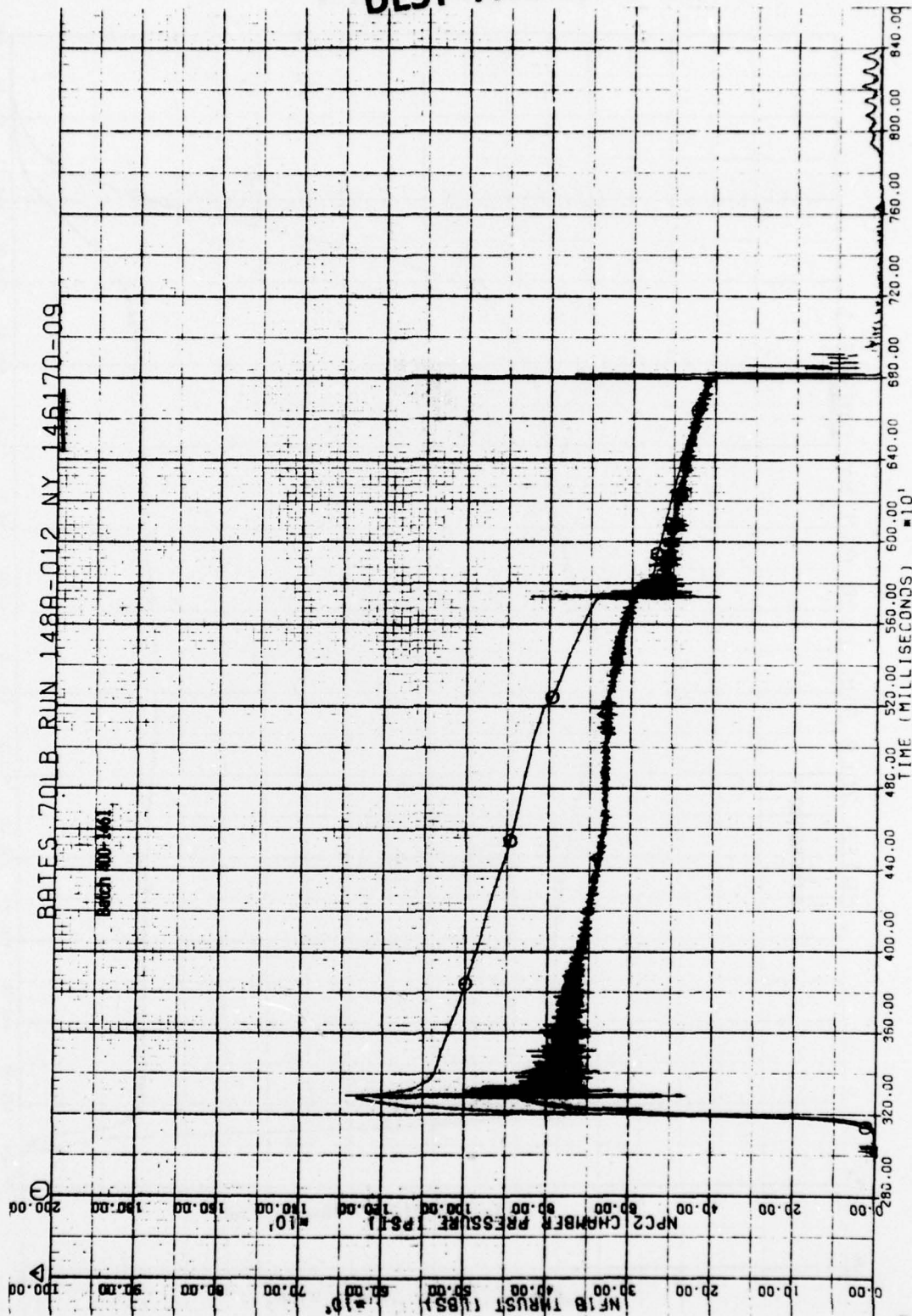
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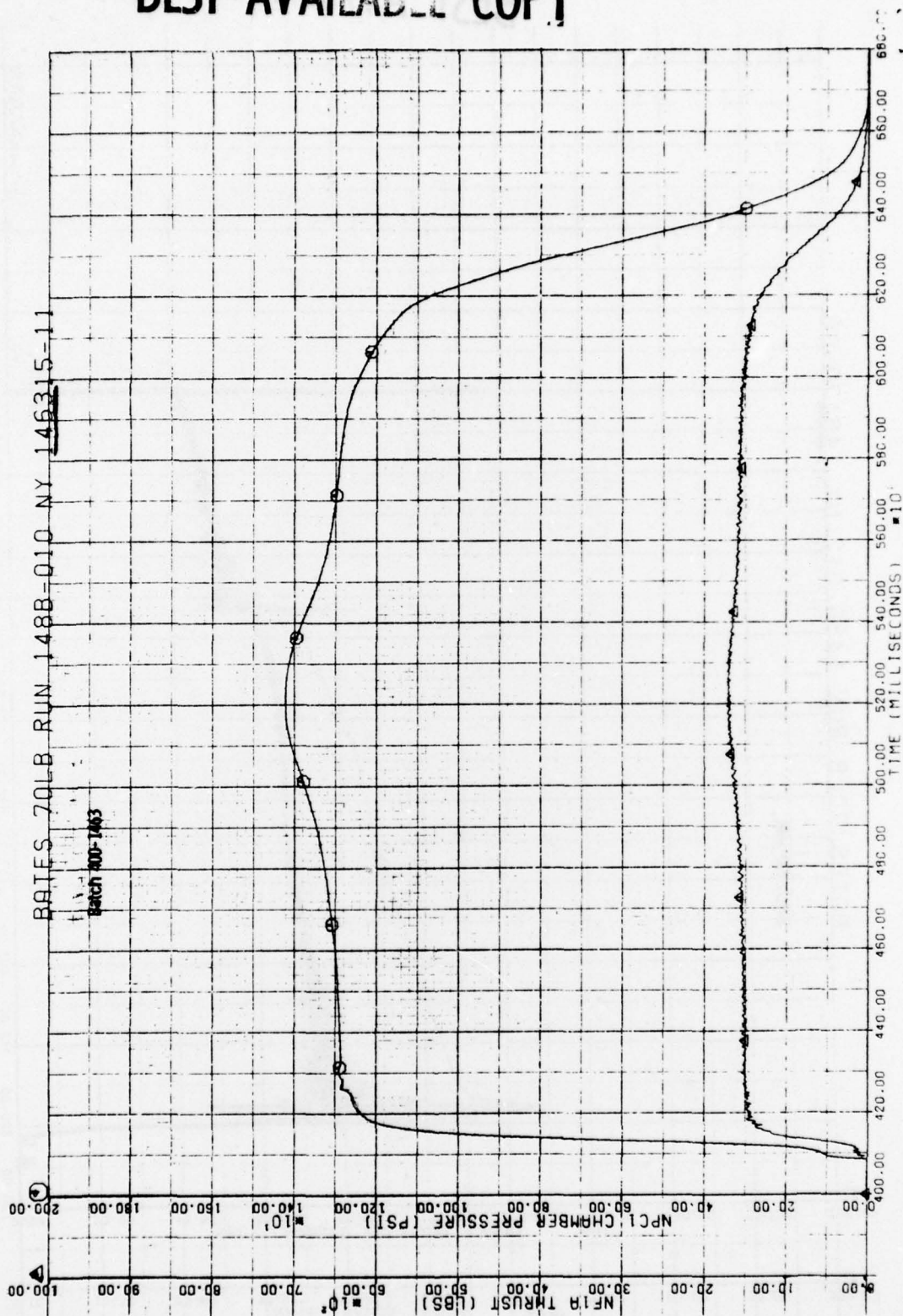
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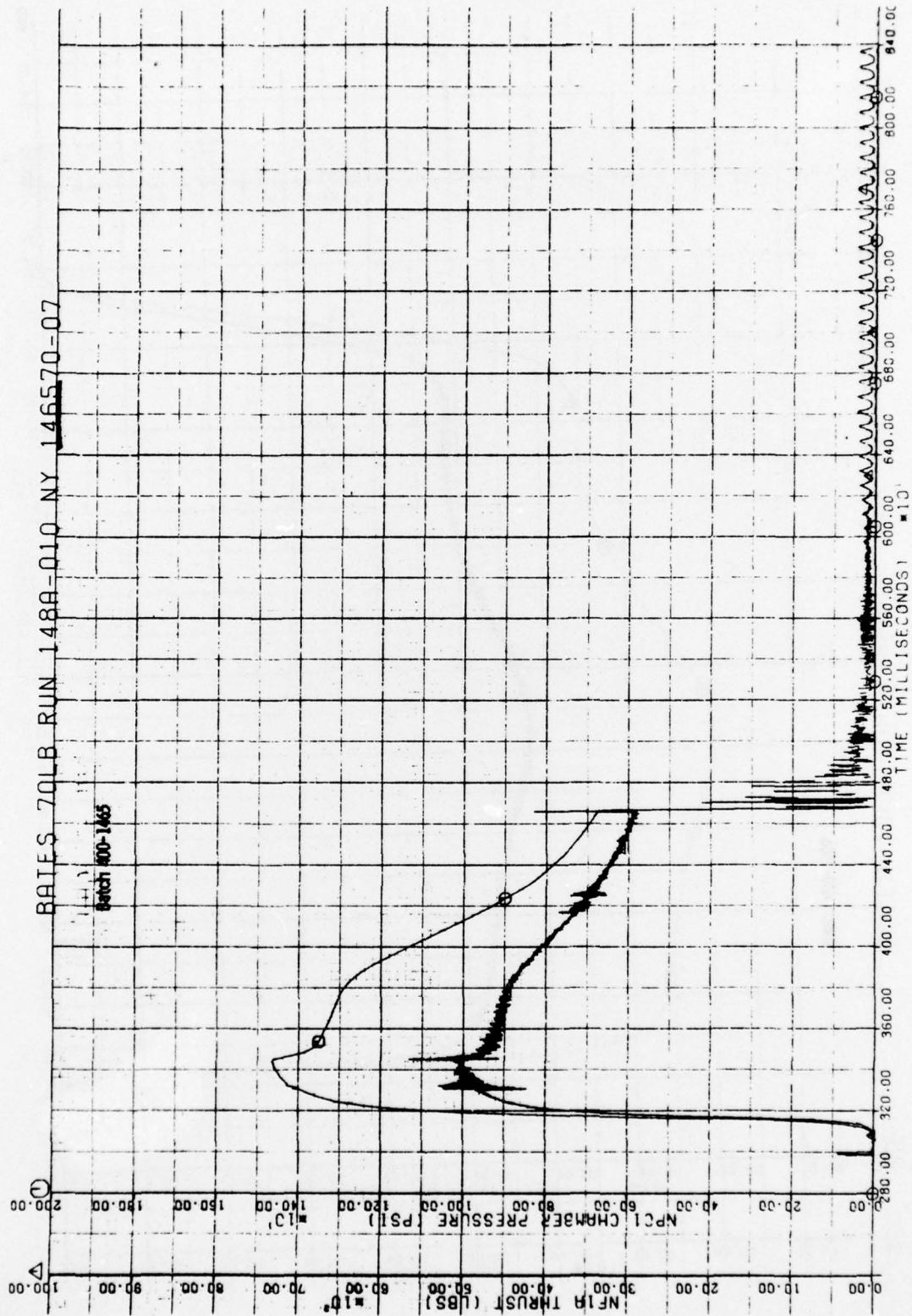
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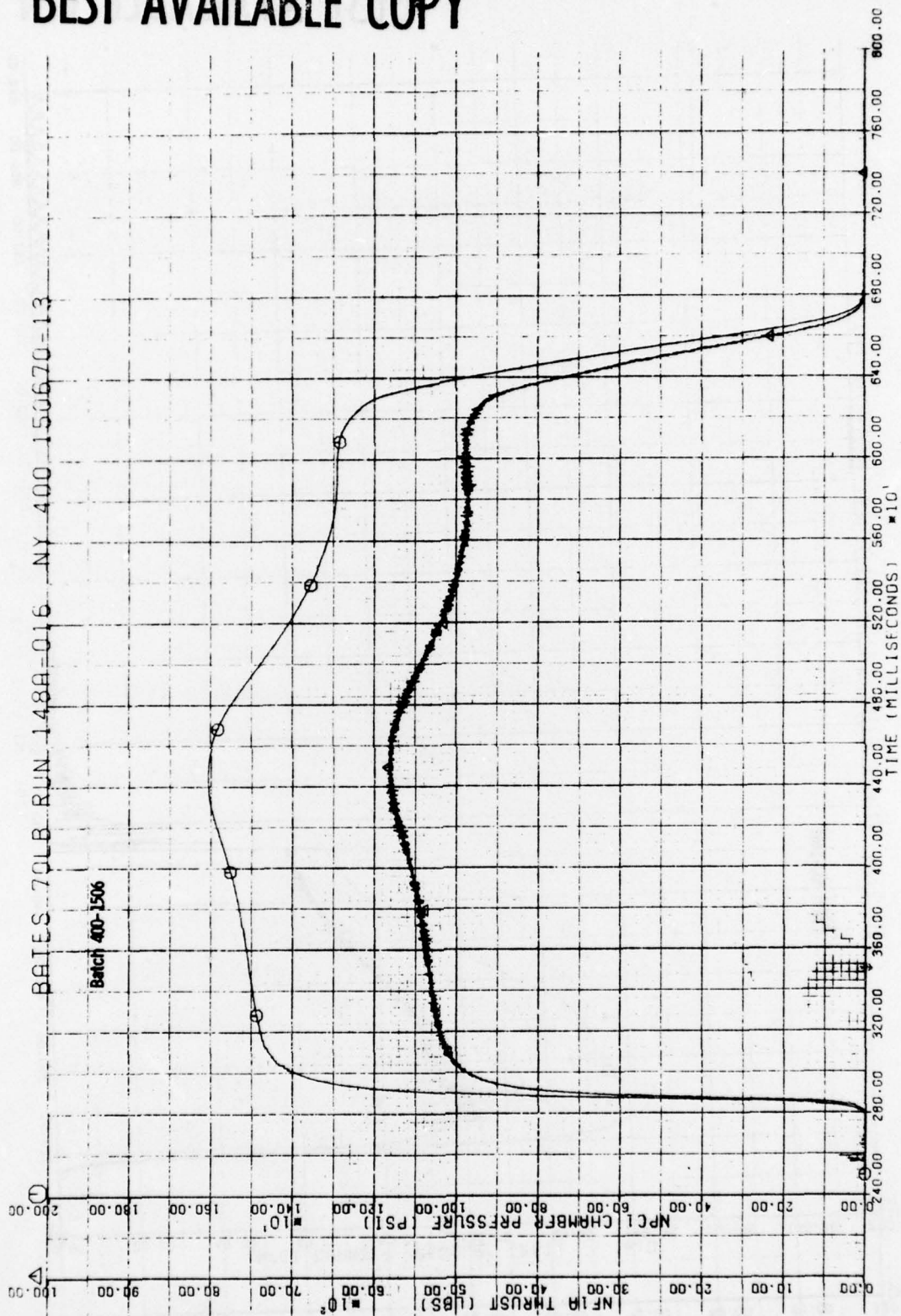
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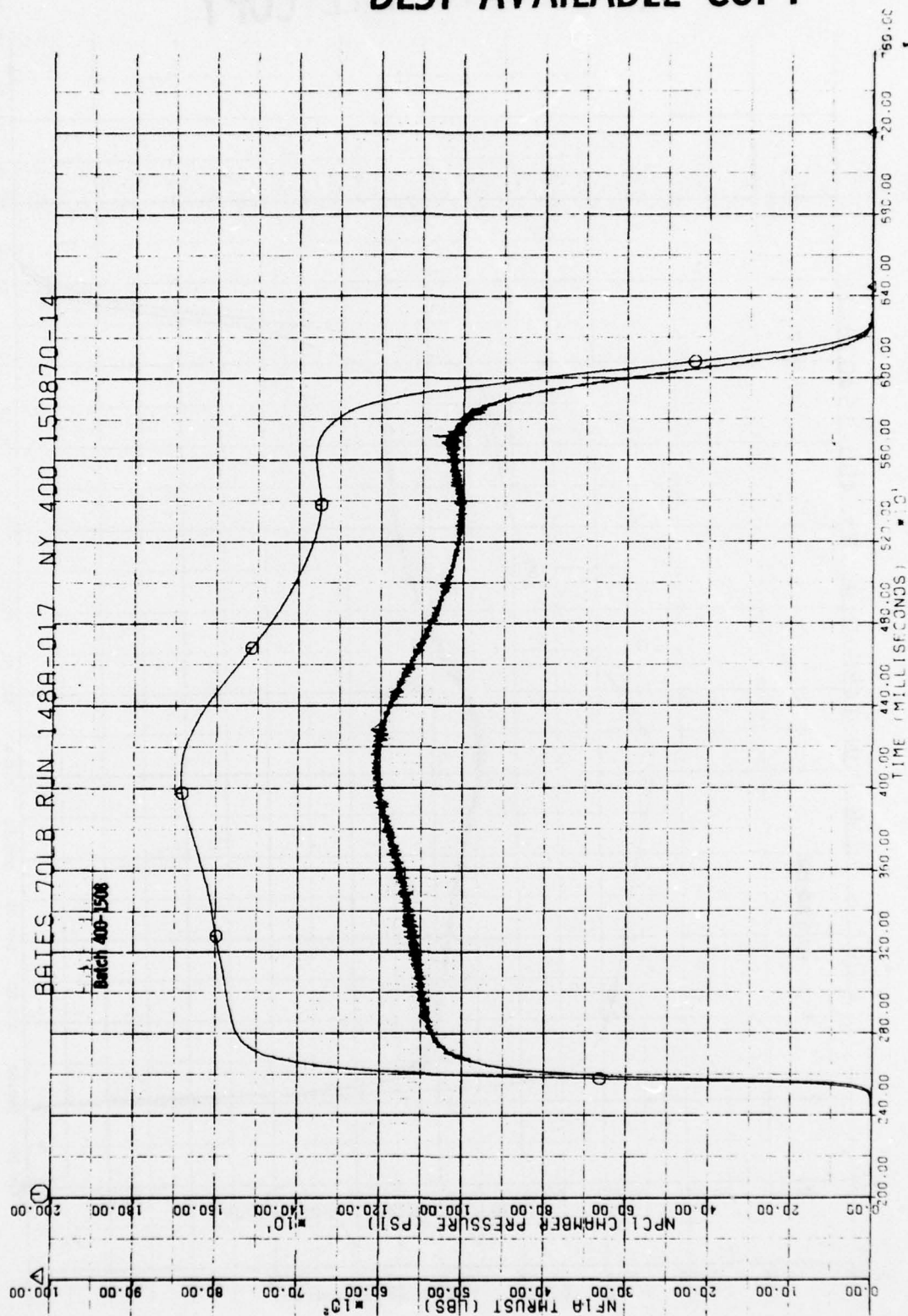
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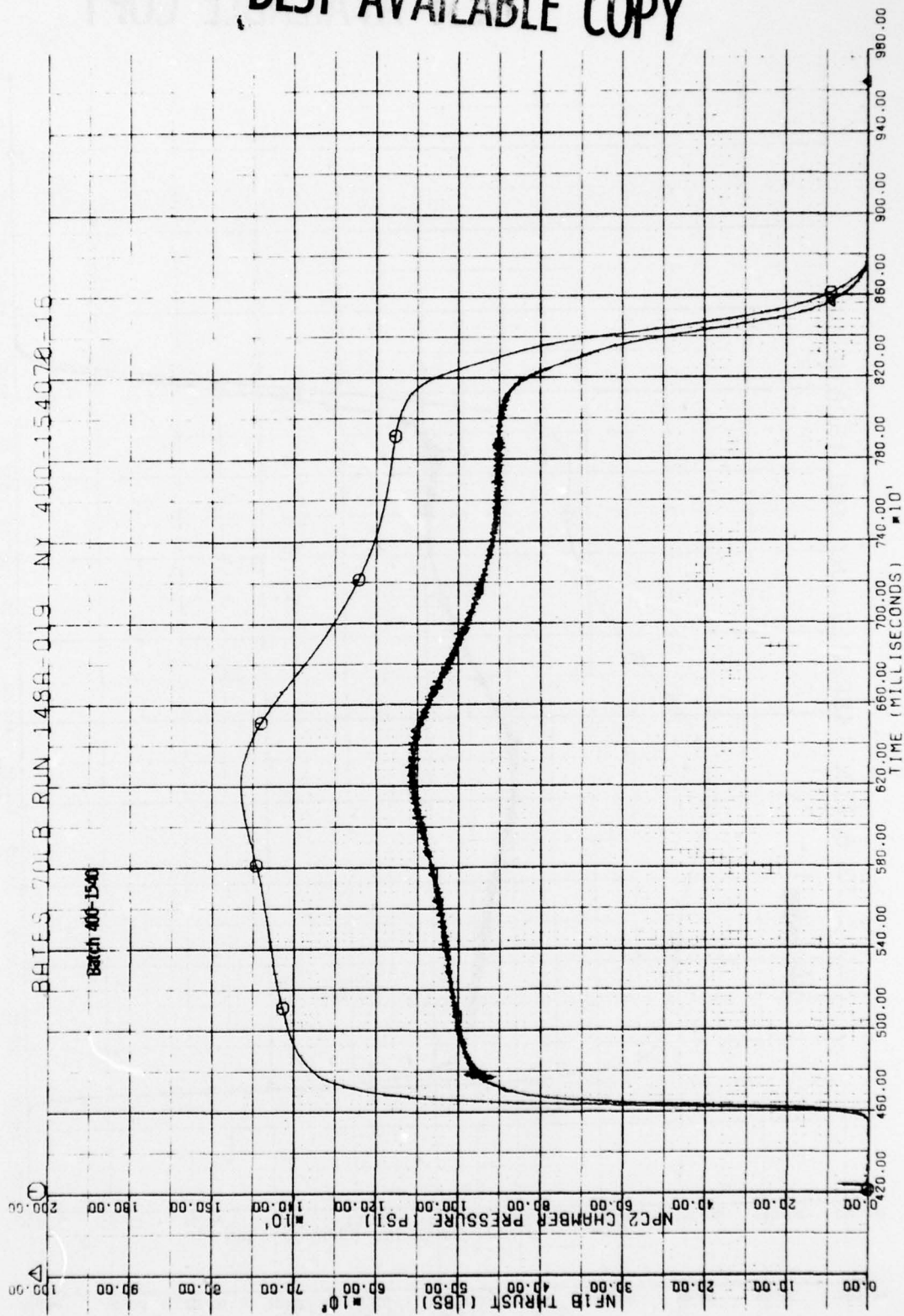
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